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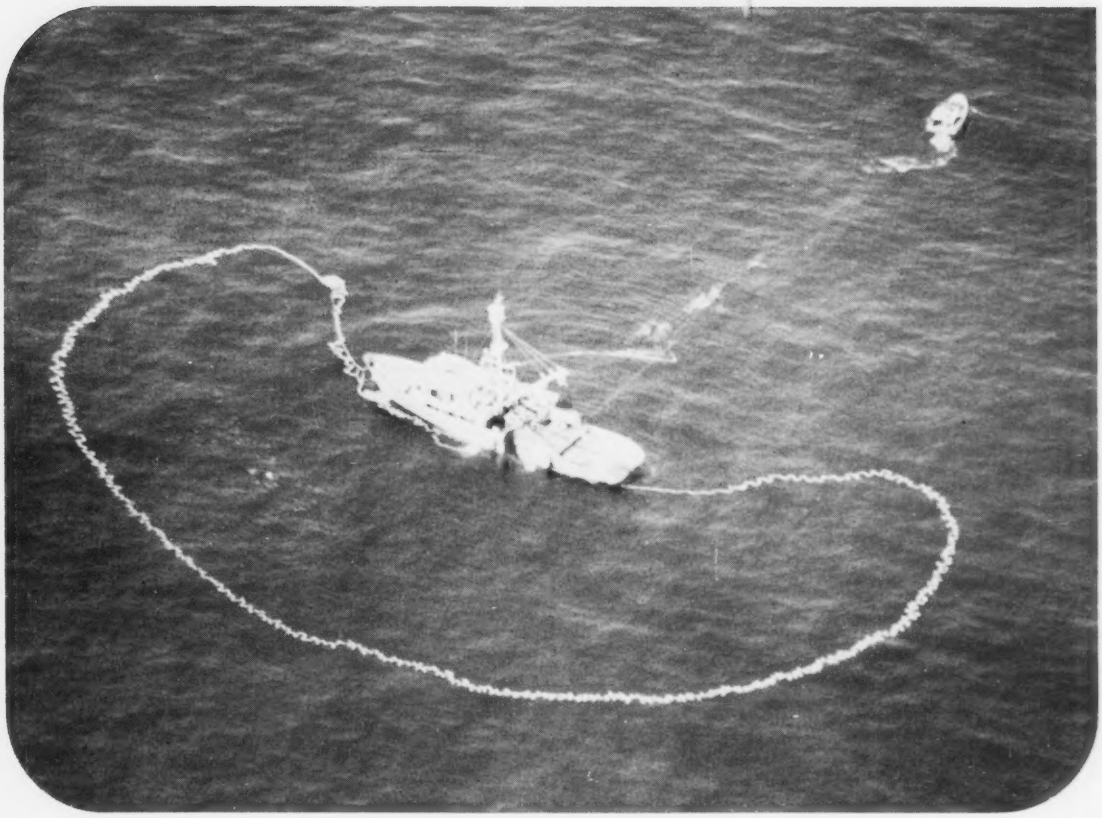

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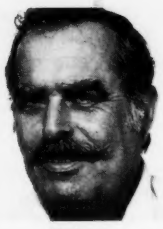
Cover: The *Gina Karen,* a San Diego-based seiner, is at about half-net, about 10 minutes before backdown. The seine skiff is functioning as a tug pulling the vessel out of the net. Net configuration here is excellent, with only mildly developed stern and bow bends. The porpoise can be seen rafted together. See the article on porpoise rescue methods beginning on page 1.

MFR PAPER 1246

# Porpoise Rescue Methods in the Yellowfin Purse Seine Fishery and the Importance of Medina Panel Mesh Size

ERIC G. BARHAM, WARREN K. TAGUCHI, and STEPHEN B. REILLY

*ABSTRACT—Introduction of the porpoise releasing method known as "backdown" by Anton Meizetich and Manuel Neves and the development of small-mesh porpoise safety panels by Harold Medina raises the question of the optimum mesh size for the panels. Medina panels of relatively standard dimensions hung from 2-inch mesh webbing had been installed in about half the nets of the U.S. tuna purse seine fleet before passage of the Marine Mammal Protection Act. The fishermen believed, and several statistical studies indicated, that use of the panel resulted in lower porpoise mortality. Despite the improved performance, however, porpoises were still being entangled in nets during the backdown process and a recent study indicates that up to 30 percent of porpoise mortality is due to this factor. Using mainly porpoise specimens taken in the fishery, measurements of penetration of porpoise snouts and flippers through mesh openings of 2, 1⅞, 1½, and 1 inches were made to elucidate the potential reduction in porpoise entanglement that could be expected through use of Medina panel mesh sizes of less than 2 inches. With their jaws closed, the snouts of even the smallest specimen could not penetrate 1-inch mesh, and the average penetration with the jaws open was grossly reduced as were penetrations of pectoral fins. Because of added weight and drag, additions of large sections of small-mesh netting can drastically affect the buoyancy and hydrodynamic performance of purse seines. Recent tests of porpoise "aprons" and "chutes" (trapezoidal-shaped sections of webbing appended to Medina panels) promise a means of making small-mesh netting compatible with tuna purse seine performance.*



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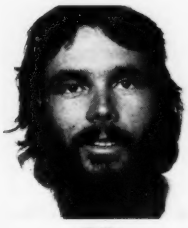

Reilly

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*Stephen B. Reilly, a former porpoise observer aboard U.S. commercial tuna vessels, is a graduate student at California Polytechnic State University, San Luis Obispo, Calif. Much of the work reported in this paper was carried out in 1973–75 when the authors worked together at the Southwest Fisheries Center, La Jolla, Calif.*

## INTRODUCTION

Historically, fishermen have attempted to select netting of a mesh size that retains their target species while permitting unwanted species or sizes to escape. The situation in the eastern tropical Pacific U.S. tuna purse seine fishery, however, is complex. In this fishery the majority of the most important species, the yellowfin tuna, *Thunnus albacares,* is taken by scouting, herding, and setting purse seine nets on schools of porpoise with which the larger yellowfin associate (Perrin, 1968; Green et al., 1971). Three species of pelagic dolphins, or porpoise as they are more commonly referred to in the fishery, are primarily exploited by the fishermen. In order of decreasing importance, these species are: the spotted dolphin, *Stenella attenuata;* the spinner dolphin, *S. longirostris;* and the common dolphin, *Delphinus delphis.* In the fishery, these cetaceans are referred to respectively as spotters, spinners, and whitebellies. The races and distributions of the stocks are described by Perrin (1975) and Evans (1975).

When "porpoise fishing," as the method is called, the objective of the fishermen has been to retain the tuna and free the porpoise, but because the two forms are approximately the same size it is not possible to separate them by mesh-size choice. While capable of easily leaping over the corkline, porpoises show little tendency to escape in this manner. Thus, in the early years of the fishery, and despite the efforts of the fishermen, large numbers of porpoise were killed when they became entangled in the nylon webbing of nets or were sacked up with the tuna.

Because of the fishermen's subsequent development of a porpoise rescue procedure known as "backdown" and introduction of

the related "Medina panel," mesh-size selection became an important consideration, and as a result of passage of the Marine Mammal Protection Act (Public Law 92-522, 92nd Congress, H. R. 10420, 21 October 1972), a consideration that has legal as well as practical implications. This law also mandated the National Marine Fisheries Service (NMFS) to work with the fishermen to develop porpoise saving gear and methods. In the spring of 1973, research directed towards this objective began at the Southwest Fisheries Center in La Jolla, Calif., under the direction of Richard McNeely, who had studied tuna purse seining following the conversion from pole-and-line fishing (McNeely, 1961).

Several innovations such as hydraulic gates, skimmer nets, and various kinds of acoustic signals had previously been tried by Southwest Fisheries Center personnel. None had shown real promise. Therefore, in its early stages, the philosophy of the program was to work with the existing purse seining system and to help perfect those rescue procedures that the fishermen had developed, that they believed in, and that many of them were already using, to rapidly effect as great a reduction in porpoise mortality as possible. Progress in this work has previously been reported (Department of Commerce, 1974; Staff, Porpoise/Tuna Interaction Program, Oceanic Fisheries Resources Division, 1975 and 1976).

The objectives of this paper are to: 1) review the history of porpoise rescue procedures developed by the fishermen; 2) present measurements of the degree of penetration of porpoise appendages through various mesh sizes; and 3) to point out the importance of mesh-size selection.

## MEDINA PANEL HISTORY

Prior to passage of the Marine Mammal Protection Act, fishermen experimented with methods and gear modifications that would reduce the incidental kill of porpoise. These efforts resulted in two related developments, "backdown" and the "Medina panel"

### Backdown

Running a vessel in reverse to pull the corkline underwater to dump unwanted catches may have occasionally been used in the California sardine or mackerel purse seine fishery, but Anton Meizetich, captain of a small, San Pedro seiner, the original MV *Anthony M.*, is generally credited with developing this method of porpoise removal in 1959-60. Hearing of its success, Manuel Neves, captain of the MV *Constitution*, in 1961 demonstrated to his crew the effectiveness of the method in saving porpoise and time, and the use of backdown, as it came to be called, spread rapidly through the San Diego-based fleet which included the majority of the seiners that regularly fish on porpoise.

Various fishermen developed their own modifications of the method, but essentially, the process is executed by recovering about two-thirds of the net aboard the seiner, securing the hauling end and then, aided by the seine skiff functioning as a tug, moving the vessel in reverse in a wide arc. Coe and Sousa (1972) gave a detailed description of the methods used on one seiner in 1972. Pressure caused by pulling the netting through the water forms the net into a long channel approximately 90–110 m long and about 15–20 m wide (Fig. 1). As the backdown channel develops, porpoise tend to congregate at the extreme end or apex, while the tuna generally range back and forth in the channel between the porpoise and the seiner. At times when the tuna are near the seiner the vessel is backed rapidly, causing the corkline to submerge at the end of the channel where the porpoise are concentrated. The motion of the vessel continues to pull the corkline down and out from under the porpoise (Fig. 1). Usually, three or four such rapid backdown surges are necessary to spill the porpoise out of the net.

During the maneuver, the vessel's speed is crucial, for if backdown is too slow the porpoise may tend to swim with the net rather than passing over the submerged corkline. (This seems to be particularly true of spinner porpoise although behavior of the porpoises varies in different geographical locations.) Those porpoise that could not be backed out and that could be reached were hand-hauled over the corks by crewmen entering the water or working from a small skiff (cork tender). Porpoise were also removed from the net when concentrated with the fish in the bunt or bow end of the net at the time the captured tuna were landed.

Before and following passage of the Marine Mammal Protection Act, "skipper-gear workshops" were sponsored by the American Tunaboat Association in 1972, 1973, and 1974. At these meetings techniques were exchanged between fishing captains for refinement of the backdown process. During this period the stationing of the cork tender manned by one or two crewmen at the backdown area to pull up on the corkline whenever the loss of fish was threatened to aid porpoise over the corks, and to free porpoise entangled in the net became more widespread throughout the fleet (Fig. 1).

### The Medina Panel

The second development, the Medina or safety panel, is closely related to backdown. In normal, trouble-free sets porpoise encircled by a purse seine usually loll at the surface, swim and dive in the open area of the net, and tend to avoid the corkline and the walls of webbing, but when porpoises are concentrated in the end of the backdown area and come in contact with the net, the potential for entanglement is greatly increased. Thus, despite the importance of backdown as a rescue technique, some animals are "gilled" in the net during the process and, unable to reach the surface to breath, they usually suffocate.

In the fall of 1970, tuna fishermen and scientists from the Southwest Fisheries Center met at the offices of the American Tunaboat Association to discuss porpoise rescue methods. Harold Medina, captain and owner of the MV *Kerri M.*, argued that strategically positioned smaller mesh would reduce the chances of porpoise entanglement. In December of that year while fitting out for the first trip of the 1971 season in Panama, Medina replaced the 4¼-inch (10.80-cm) stretch-mesh webbing in the top strip of his net in the backdown area with a section of 2-inch (5.08-cm) stretch-mesh webbing 720 feet long by 33 feet deep (about 219.5 by 10 m).

A brief parenthetic discussion of netting may be helpful at this point. Net webbing is measured from the center of one knot to the center of an adjacent knot while the webbing is stretched. Originally, tuna purse seines were hung with 4⅛-inch (10.5-cm) stretch mesh, but in recent years 4¼-inch (10.8-cm) mesh has become standard. The webbing is made from different types and sizes of twine spun from various synthetic fibers. Therefore, mesh dimensions are not critically standardized. Further, once in use, the

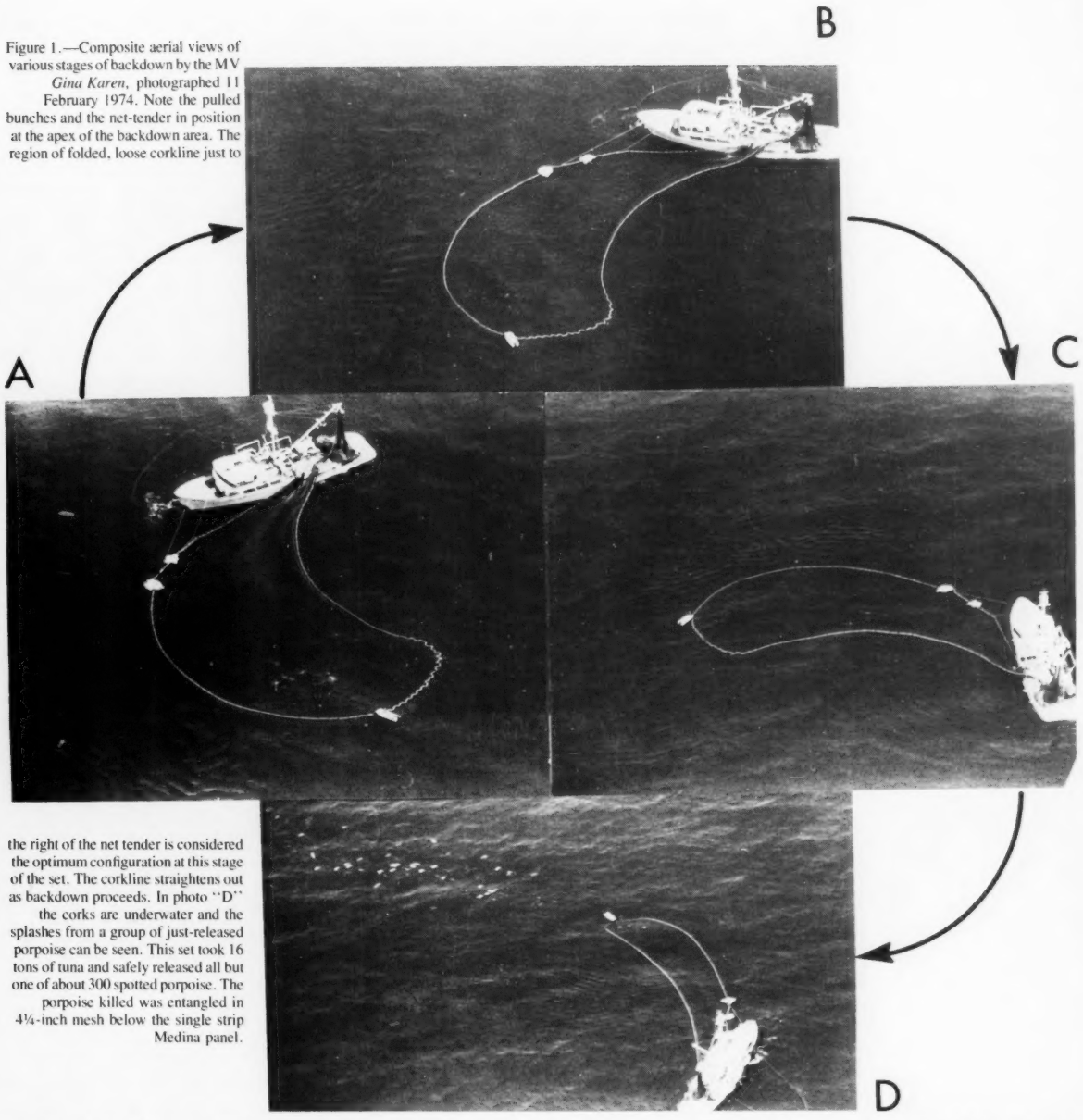



Figure 1.—Composite aerial views of various stages of backdown by the MV *Gina Karen*, photographed 11 February 1974. Note the pulled bunches and the net-tender in position at the apex of the backdown area. The region of folded, loose corkline just to the right of the net tender is considered the optimum configuration at this stage of the set. The corkline straightens out as backdown proceeds. In photo "D" the corks are underwater and the splashes from a group of just-released porpoise can be seen. This set took 16 tons of tuna and safely released all but one of about 300 spotted porpoise. The porpoise killed was entangled in 4¼-inch mesh below the single strip Medina panel.

mesh openings do not retain their original size but become smaller as the twine shrinks. As a general rule, webbing shrinks about 5 percent a year for the first 2 years it is used and then tends to stabilize. Purse seines are constructed by lacing together long strips of webbing that are about 120 fm (about 219.5 m) in length and usually 100 meshes deep (about 5.5 fm, or about 10 m). Thus, one strip of 4¼-inch mesh that has undergone shrinkage can conveniently be replaced by two strips of 2-inch mesh, each 112.5 meshes deep.

Later in the 1971 season a section of webbing similar to that used by Harold Medina was employed by his cousin, Joseph Medina, Jr., on cruises of the MV *Queen Mary*. These highly experienced and skilled skippers concluded that the smaller mesh in the backdown area was effective in reducing porpoise entanglements and did not degrade the performance of their nets. Harold Medina made available diagrams and instructions of panel installation and strongly recommended its use to other fishermen. By the end of the 1972 fishing season similar panels had been installed in the nets of approximately 40 to 50 percent of U.S. tuna seiners. Further voluntary adoptions raised the percentage of the fleet's nets equipped

with such a panel to about 60 to 70 percent by the end of 1973.

While there was a general standardization of panel dimensions, each vessel operator experimented on the exact placement of the panel working out what he believed to be the most effective arrangement for his boat and fishing techniques.

Of primary importance to the fishermen in any net modification is its effect on what can be called "net control", that is, the ease and rate which the backdown area can be submerged to facilitate passage of the mammals over the corkline and out of the net at the opportune time while still being able to obtain a rapid rise of the corks to the surface to retain fish that may swim into the backdown area seeking escape. Aside from the buoyancy of the net and the skill and judgment of the captain and crew, such factors as the displacement, weight, and movement of the vessel, its power capabilities, responsiveness to the throttle, turning radius, availability of a bow thruster, and the towing, rigging, and operational characteristics of the seine skiff affect net handling. The tendency of webbing to foul with jellyfishes and other organisms and the vagaries of wind and sea can be added to these factors.

Most fishermen and industry spokesmen were convinced of the effectiveness of the Medina Panel. With some qualifications, four statistical studies completed between 1972 and 1974 on steadily increasing amounts of data obtained by NMFS observers during commercial fishing cruises (and with increasing sophistication) have reached the same conclusion (NOAA Tuna-Porpoise Committee, 1972; Stauffer, 1974; Norris and Dohl, 1974; Fabrick and Faverty, 1974). Several factors complicated the statistical analyses. The early data were sparse and obtained on vessels whose owners and skippers voluntarily accommodated NMFS observers rather than on randomly selected seiners. Thus, the results may not have been representative of fleet performance (placement of observers on randomly selected vessels was initiated in 1974). More importantly, the majority of the porpoise kill on any given trip occurs in a small percentage of the sets, usually where a problem has developed to hinder or slow the procedures. These problems frequently develop when a set has been made on either or both a large number of porpoise and a large tonnage of yellowfin tuna. In some cases the net has collapsed, that is the corklines have come together restricting the amount of open surface area, or large pockets or canopies have developed entrapping the porpoise in webbing before the operation has progressed to the backdown phase of the set. In such cases, obviously, it is difficult to fairly evaluate the reduced entangling factor of small mesh in the backdown area.

## NMFS GEAR PROGRAM

Despite the improved performance of Medina panel-equipped nets over those which lacked the smaller mesh sections, underwater observations by NMFS gear specialists during charter cruises in 1972 and the records of porpoise observers from commercial fishing trips indicated that some porpoises were still entangling in nets during backdown. The animals were ensnarling in both the 2-inch web of the Medina panel and below or to the sides of the panel in the 4¼-inch mesh. Clearly, tests of more extensive panels hung with webbing of smaller than 2-inch mesh were strongly indicated.

### Experimental Net

Following modeling studies, in the spring of 1973 an experimental purse seine was designed and built. The objectives of the design were to provide a large volume of water to safely contain large numbers of porpoise within a fully pursed net and at the same time create a deep, rapid-sinking net that would be advantageous on school fish sets that do not involve porpoise. Construction of the net also provided an opportunity to experiment with the Medina panel.

Although a few fishermen had used 1⅞-inch (4.45-cm) mesh knotless webbing, the standard Medina panels installed in the fleet's nets had mainly been hung with the equivalent of one strip of 2-inch stretch-mesh knotted webbing. There are several cogent reasons for using this dimension mesh: it is regularly hung in the large dip nets or brailers used to scoop tuna out of the sacked-up bunt end of the purse seine, and is therefore usually available; the 4¼-inch webbing shrinks to approximately 4 inches after moderate usage and the 2-inch mesh can be easily laced in, two meshes to one; and even though the small mesh will suffer shrinkage after use, the lines of strain work well in the net with the larger mesh.

The Medina panel of the experimental net was constructed from 1½-inch (5.08-mm) stretch-mesh webbing that is generally used for shrimp trawls. This webbing was extended in depth to the equivalent of three strips deep (about 30.2 m), so that the small mesh extended down to reach the floor of the channel where porpoise frequently dive during backdown. The panel was also extended in length to reach from the stern tie-down point through the third bunch which is generally gathered along side the bow of the vessel at backdown (see Fig. 1). This design would then afford the porpoises protection from large mesh around the entire periphery of the backdown channel. Lighter-than-normal thread used in the 1½-inch mesh webbing tended to compensate for the added drag caused by the increased amount of small netting.

Early tests of the net during the fall of 1973 on the cruise of the MV *John F. Kennedy* indicated some defects, but a highly encouraging low kill rate was achieved. Both the NMFS gear specialist aboard, Jerry Jurkovich, and the captain, Lionel Souza, credited the more extensive, small-mesh Medina panel with much of the success. Only one porpoise was noted entangled in the small mesh, and that was where the 1½-inch mesh had been torn. Distracting to some extent from the success of this trip was the fact that it was a research charter that granted fishing rights for yellowfin tuna inside the Inter-American Tropical Tuna Commission Yellowfin Regulatory Area (CYRA) and therefore was not typical of the more competitive fishing that prevails earlier in the year during the open season.

In June 1974, a captain of a new seiner volunteered to further test the net and to carry Jerry Jurkovich. The trip was made to the area west of the CYRA where the vast majority of the fishing is on porpoise and conducted under rigorous weather and sea conditions. This cruise achieved what was at that time a record low kill-rate. The small-mesh Medina panel again was considered by Jurkovich of major importance in this performance.

### Small Mesh Considerations

Based on these successful, although limited tests of the more extensive smaller mesh Medina panel and the common sense principle that tapered objects, such as porpoise snouts and fins, will not penetrate as deeply into small openings as they will into larger

openings, it would seem that the more extensive smaller mesh panels would have been rapidly introduced into the fleet. However, in the real world of tuna fishing other considerations are operative as well.

Purse seines in the modern tuna fleet tend to be tailored to the size of the vessel that will deploy them and to a lesser extent to the type of fishing that will mainly be conducted. Basically, there are three types of fishing: porpoise fishing, log fishing, and school fishing. In the latter cases, schools of tuna that are not associated with porpoises are located and entrapped. The larger vessels use the larger nets and school fishing nets are generally about 100 fm longer than porpoise fishing nets. Most of the newer vessels fishing on porpoise now use nets 600–700 fm (1,097–1,280 m) in length and 10–14 strips deep (about 101–141 m). Because of its added weight, drag, and tendency to clog, addition of large amounts of small-mesh webbing to a net of this size must be approached with caution, for the buoyancy of the net can be lessened to the point that once the corks go under and are squeezed by increasing water pressure they will not rise to the surface. In such a situation, the net can sink to the point where it and even the vessel are in jeopardy.

Again, what appears to be a simple matter of mesh-size opening is complicated by numerous factors. For example, the stretch of the webbing at any given moment can close the area of the openings both before or after penetration of the animal appendage. The angle of incidence of the animal appendage in relation to the plane of the webbing, the dimensions and shape of the teeth or roughness of the skin that would tend to catch and hang in the thread, and the behavior of the animal which in turn may be affected by many variables, are other imponderables that are difficult to predict.

### Live Animal Experiments

In view of the above discussed considerations, the most valid tests of mesh-size entanglement factors should be made on live animals under experimental conditions. Such experiments were planned for the summer of 1973 as part of the behavioral studies undertaken for NMFS by the University of California, Santa Cruz, Calif. (Norris and Dohl, 1974). The problems of obtaining and maintaining live specimens of those stocks utilized in the fishery were insurmountable. Thus the Hawaiian spotted dolphin or "kiko", a race of *Stenella attenuata,* was chosen for the experiments. Unfortunately, the animals did not do well in the only cages available for use at the U.S. Navy Undersea Laboratory Marine Mammal Facility at Kaneohe Bay, Oahu, Hawaii. Of the eight animals captured and placed under husbandry, seven died. Because of the inherent dangers of the experiment, the remaining animal was only used in a series of trials of passage through net openings of various sizes similar to the experiments of Perrin and Hunter (1972). As an aside, it should be noted that this animal survived the tests and was released in the general area of his capture.

A casual observation made by Dohl (pers. commun.), but not included in the above cited report, is also of interest here. In all observed cases, when a porpoise had pushed its rostrum and lower jaw through a hole in their wire mesh enclosures, the animals kept swimming and forcing themselves further into the opening until they became exhausted and died. The animals never attempted to withdraw from the ensnaring hole. This behavior also seems to be typical of porpoises entangled in tuna nets. As the fishermen say, "porpoise have no reverse gear."

**Table 1.—Relative life stages and measurements (in centimeters) of porpoise specimens used in the appendage penetration tests.**

| Specimens | | Total length | Rostral length | Jaw ×-section closed | | Jaw ×-section open | | | | Pectoral fin length |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Upper | | Lower | | |
| Numbers | Description | | | Width | Depth | Width | Depth | Width | Depth | |
| 1 (WFP 281) | Spinner, large adult female | 185.0 | 13.7 | 3.3 | 3.5 | 3.4 | 1.8 | 3.2 | 2.0 | 23.5 |
| 2 (GMA 115) | Spinner, large juvenile female | 127.5 | 11.3 | 3.1 | 3.4 | 3.1 | 1.5 | 3.2 | 2.1 | 20.1 |
| 3 (WFP 285) | Spinner, medium juvenile male | 115.0 | 8.5 | — | — | — | — | — | — | — |
| 4 (WFP 290) | Spotter, medium adult female | 182.0 | 11.0 | 3.3 | 3.6 | 3.3 | 2.1 | 2.6 | 2.0 | — |
| 5 (WFP 467) | Spotter, large juvenile female | 144.0 | 9.4 | 3.2 | 3.6 | 3.2 | 1.5 | 2.5 | 2.1 | — |
| 6 (WFP 468) | Spotter, small juvenile male | 87.0 | 5.5 | 2.6 | 3.0 | 2.6 | 1.6 | 2.5 | 1.4 | 14.5 |
| 7 (NUC 385) | Whitebelly, large juvenile female | 146.0 | 11.6 | 4.2 | 4.0 | 4.0 | 2.3 | 3.9 | 2.6 | 24.2 |

## PORPOISE APPENDAGE PENETRATION TESTS

Unable to acquire data obtained with live animals, we then carried out the tests described below on dead specimens to quantify the relative potential entanglement factor of various mesh sizes. The tests were done in April 1974 at the Southwest Fisheries Center.

### Specimens

Seven animals representing the three porpoise species of major importance were used in the tests: three spinner dolphins, *Stenella longirostris;* three spotted dolphins, *S. attenuata;* and one common or whitebelly dolphin, *Delphinus delphis.* The specimens of the first two species were collected in the eastern tropical Pacific by NMFS observers on commercial fishing vessels and are representative of porpoises utilized in the fishery. The *Delphinus* was taken dead from a Baja California, Mexico, beach by Navy Undersea Center personnel and was probably from a stock that is not involved in the fishery (Evans, 1976). All specimens had been frozen and were thoroughly thawed before the tests were performed. To the extent possible, representative size classes were selected for measurement. Their sex and relative life stage is indicated in Table 1. In the cases of three specimens, number 3 spinner and numbers 4 and 5 spotters, only the heads had been collected and pectoral fin measurements and tests could not be made. The number 3 spinner specimen was damaged to the degree that critical cross sectional measurements were impossible. The nature of the longitudinal measurements made on specimens is indicated in Figure 2, and the pertinent dimensions are listed in Table 1.

### Netting

Four different stretch-mesh sizes of coal-tar treated nylon netting were used: 1-inch, No. 18 thread; 1½-inch, No. 18 thread; 1⅞-inch, No. 54 thread (commercially known as 2-inch knotless); and 2-inch, No. 36 thread. (The metric equivalents for mesh

sizes are shown in Figure 3.) The thread sizes indicate the number of yarns used for a strand and are not standardized diameters. The 1½-inch mesh webbing was a remnant of the panel built into the experimental net; the 1⅞-inch monofilament mesh was obtained from a commercial source and was not on hand at the time that specimen number 1 was run. The 1- and 2-inch mesh webbing was unavailable commercially at the time of the study and was hand-made by

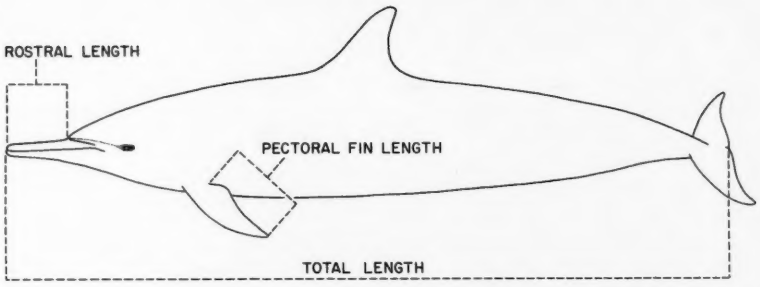
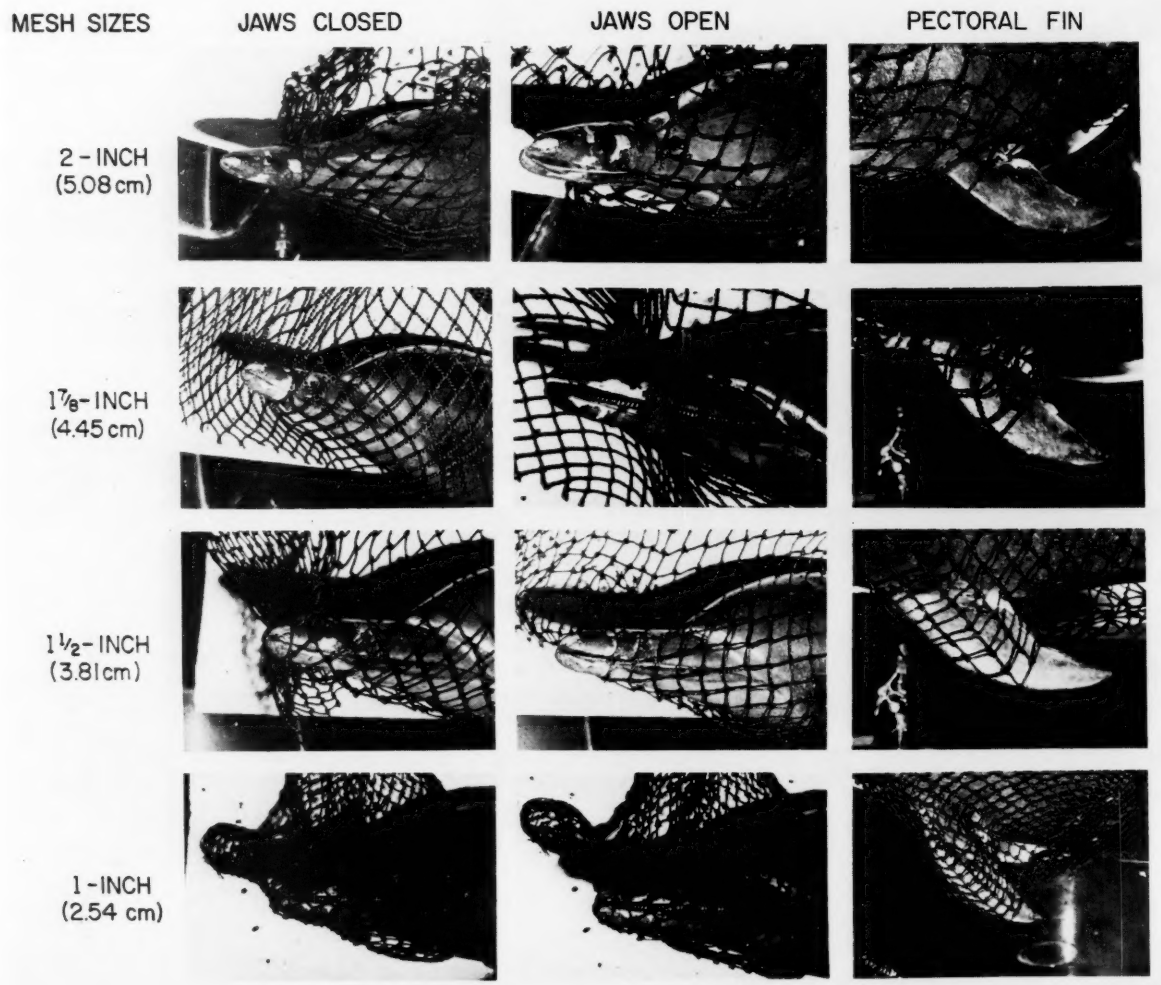



Figure 2.—Longitudinal meaurements made on porpoise specimens used in appendage penetration tests.

Figure 3.—Photographs of penetration tests performed on specimen number 2, a relatively large juvenile female spinner porpoise. (Total length, 127.5 cm; rostral length, 11.3 cm; pectoral fin length, 20.1 cm.)



a professional net builder. All the netting was new and had not been subjected to wear, stretch, or shrinkage.

### Method

The netting was snugly pulled down over the rostrum or snout, first with the jaws tightly closed and then repeated with the jaws slightly agape. In the latter case, a net bar was inserted in the mouth and the mandible would penetrate one mesh opening and the lower jaw an adjacent mesh opening. Measurements of penetrations were made with a caliper from the tip of the upper jaw to the net twine. These measurements were then compared to the full-length of the rostrum (measured from the tip of the upper jaw to the apex of the melon) to derive the percent penetration of that specimen. Penetration of the pectoral fin, or "flipper," was similarly measured for the four entire specimens that were available. Measurements were rounded to a millimeter.

### Results

Representative photographs of the tests are shown in Figure 4. The appendage penetration measurements through the four mesh-size openings for the three classes of tests, "jaws closed," "jaws open," and "pectoral fin," are listed in Table 2. The percent penetrations (depth of penetration/length of appendage × 100) are also listed and averaged in Table 2, and these average ratios are graphed in Figure 4.

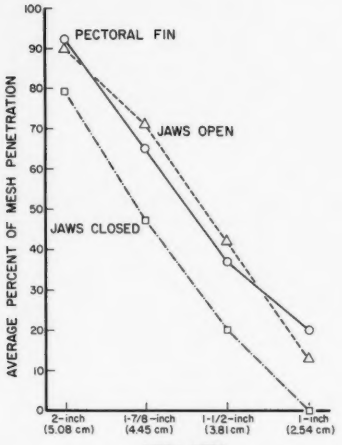



Figure 4.—Average ratios of percent penetration of porpoise appendages through the indicated mesh sizes.

The measurements demonstrate a direct relationship between the depth of penetration and mesh size, and the decreases are approximately linear and about the same rate for all three classes of tests (Fig. 3). Comparing the results for 2-inch and 1½-inch meshes, a marked decrease in penetration was measured for the smaller mesh. With the jaws closed the decrease was 75 percent; with the jaws open when two openings are involved, 53 percent; and the flipper penetration was reduced 60 percent. Surprisingly, the 1⅞-inch mesh (2-inch knotless), a coarse filament nylon net, also proved considerably lower than the 2-inch mesh. This was apparently due to the larger and coarser twine used in the netting. This twine was also more abrasive to the animal's skin than that of the other netting. Finally, the 1-inch mesh by far allowed the least penetration. With the jaws closed there was no penetration for any specimen tested (a reduction of 100 percent from the 2-inch average). With the jaws open, the average penetration was limited to only 13 percent, 86 percent less than the 2-inch measurement and also a marked reduction over the 1½-inch mesh.

Pectoral fin penetration of the four available specimens was restricted to only 20 percent, a decrease of 78 percent over that for the largest mesh.

**Table 2.—Porpoise appendage penetration measurements (in centimeters), and the percent of penetration relative to the length of the appendage for four sizes of net mesh openings.**

| | 2-inch mesh | | ⅞-inch mesh | | 1½-inch mesh | | 1-inch mesh | |
|---|---|---|---|---|---|---|---|---|
| Test specimens | cm | % | cm | % | cm | % | cm | % |
| Jaws closed | | | | | | | | |
| 1 Spinner, large adult female | 9.0 | 66 | — | — | 1.5 | 11 | 0.0 | 0 |
| 2 Spinner, large juvenile female | 9.4 | 83 | 4.9 | 43 | 2.3 | 20 | 0.0 | 0 |
| 3 Spinner, medium juvenile male | 8.5 | 100 | 3.4 | 40 | 1.8 | 21 | 0.0 | 0 |
| 4 Spotter, medium adult female | 8.3 | 75 | 3.7 | 34 | 1.3 | 12 | 0.0 | 0 |
| 5 Spotter, large juvenile female | 7.3 | 78 | 4.2 | 45 | 1.9 | 20 | 0.0 | 0 |
| 6 Spotter, small juvenile male | 5.5 | 100 | 5.5 | 100 | 2.6 | 47 | 0.0 | 0 |
| 7 Whitebelly, large juvenile male | 5.8 | 50 | 2.5 | 22 | 1.1 | 9 | 0.0 | 0 |
| Average % penetration | | 79 | | 47 | | 20 | | 0 |
| Reduction from 2-inch | | | | 41 | | 75 | | 100 |
| Jaws open | | | | | | | | |
| 1 Spinner, large adult female | 10.5 | 77 | — | — | 2.6 | 19 | 1.1 | 8 |
| 2 Spinner, large juvenile female | 10.8 | 96 | 6.6 | 58 | 4.2 | 37 | 1.1 | 10 |
| 3 Spinner, medium juvenile male | 8.5 | 100 | 8.5 | 100 | 4.3 | 51 | 1.6 | 19 |
| 4 Spotter, medium adult female | 11.0 | 100 | 6.9 | 63 | 3.6 | 33 | 1.1 | 10 |
| 5 Spotter, large juvenile female | 9.3 | 100 | 5.8 | 62 | 4.3 | 46 | 1.8 | 19 |
| 6 Spotter, small juvenile male | 5.5 | 100 | 5.5 | 100 | 4.4 | 80 | 1.5 | 27 |
| 7 Whitebelly, large juvenile male | 6.8 | 59 | 5.1 | 44 | 3.0 | 26 | 0.0 | 0 |
| Average % penetration | | 90 | | 71 | | 42 | | 13 |
| Reduction from 2-inch | | | | 21 | | 53 | | 86 |
| Pectoral fin | | | | | | | | |
| 1 Spinner, large adult female | 16.4 | 70 | — | — | 10.9 | 46 | 6.1 | 26 |
| 2 Spinner. large juvenile female | 20.1 | 100 | 10.7 | 53 | 7.5 | 37 | 3.7 | 18 |
| 3 Spinner, medium juvenile male | — | — | — | — | — | — | — | — |
| 4 Spotter, medium adult female | — | — | — | — | — | — | — | — |
| 5 Spotter, large juvenile female | — | — | — | — | — | — | — | — |
| 6 Spotter, small juvenile male | 14.5 | 100 | 14.5 | 100 | 5.8 | 40 | 3.1 | 21 |
| 7 Whitebelly, large juvenile male | 24.2 | 100 | 10.3 | 43 | 5.7 | 24 | 3.4 | 14 |
| Average % penetration | | 92 | | 65 | | 37 | | 20 |
| Reduction from 2-inch | | | | 29 | | 60 | | 78 |

### Discussion

The most recent analysis of data taken by NMFS observers on causes of porpoise mortality during commercial fishing trips indicate that over a 2-year period the kill caused by entanglement varies from about 28 to 55 percent depending on the species (Staff, Porpoise/Tuna Interaction Program, Oceanic Fisheries Resources Division, 1976). The rostrum is the most common appendage involved in entanglement, and the numerous, small, conical teeth frequently catch in the twine and play an important part in entanglement. Occasionally, having first become entangled by the rostrum or the jaws the porpoise roll and thrash becoming further entangled by other appendages.

Regarding the penetration test results, while reduction of penetration of porpoise rostra with smaller mesh sizes would logically be expected, the drastic limitation of penetration resulting from a 1-inch decrease in mesh size was striking. It should be noted, however, that even the 1-inch mesh would not totally exclude the tip of the jaws when they were agape. Clearly, however, the test results strongly indicate the potential reduction in entanglement that can be gained through the application of small-mesh netting.

## RECENT DEVELOPMENTS

### MV *South Pacific* Charter, 1974

As previously indicated, in the past the hesitancy of some fishermen to adopt smaller-mesh Medina panels has been based on their well-founded apprehension about the weight and drag effects of decreased mesh size that can grossly affect the hydrodynamic performance of the net. However, a relatively recent development, the "porpoise apron" may offer one solution to this problem. Designed by Richard McNeely and first tested on the NMFS charter cruise of the MV *South Pacific* in the fall of 1974, the apron is a tapered, trapezoidal section of small-mesh webbing. The apron is centered at the middle of the backdown area and the webbing section is laced in between the corkline and the Medina panel.

Because of the apron's tapered sides, the amount of webbing between the cork and chain lines at the apex of the backdown area is now longer than at the sides. This transfers the strain on the webbing from the center of the backdown area to its margins when the net is in backdown configuration. Several desirable effects result. The deep, porpoise entrapping pocket that commonly forms under the corks at the end of the backdown area tends to be eliminated. Instead, the panel and apron form a ramp that eases the porpoise over the corkline during backdown. It is therefore unnecessary to sink the corks to considerable depths with strong backdown surges, but rather a slow continuous backdown can be performed.

The *South Pacific* charter staged in Panama City, Panama, and the prototype apron was hung with locally available 2-inch mesh webbing when the intended 1¼-inch webbing was lost in air transit. The *South Pacific* charter results were highly encouraging, and the apron was left in that vessel's net for the 1975 season.

During the *South Pacific* charter, McNeely also briefly experimented with an extension to the apron called a "chute". This severely tapered, trapezoidal-shaped section of netting was hung from untarred, 1¼-inch mesh borrowed at sea from another purse seiner under charter to NMFS. From the deck of the *South Pacific* during backdown, the dark bodies of porpoise could easily be seen in contact with this light-colored webbing. The porpoise would come free without entangling. The ship's fishing captain, Joseph Scafidi, was highly impressed with the performance of the small-mesh webbing. For the 1975 season, Scafidi transferred to another seiner and he requested and received from NMFS 1¼-inch mesh webbing for testing from which he hung an apron in the net of his new vessel.

Concurrent with the *South Pacific* charter, another charter vessel, the *J. M. Martinac,* was fishing with a net that had a 120 fm Medina panel of 1¼-inch webbing. The NMFS gear technician, Daniel Twohig, also observed a striking lack of entanglement during contact with this small-mesh Medina panel.

### Voluntary April Tests, 1975

In mid-spring of 1975, a group of fishermen who had returned to San Diego following their first trips of the season met with owners and managers to discuss porpoise rescue procedures. Joseph Scafidi attended and he strongly recommended small-mesh panels and aprons. August Felando, General Manager of the American Tunaboat Association, asked for volunteers, and eight captains or managers agreed to install and test aprons during the remainder of that season.

Unfortunately, this period coincided with a world shortage of synthetic-fiber twine due to the petroleum shortage and the destruction by fire of a major twine producer's factory. Orders could only be filled after at least a 6-month delay. The vessels of the "apron volunteers" were in port for only brief periods between fishing trips, and, as a result, most of these aprons were hung with the only small-mesh netting locally available, 2-inch stretch mesh, woven from coarse nylon.

One of us (E. G. Barham) interviewed the "apron skippers" on their return from their first fishing trip with the aprons. In general, their opinions were affirmative, although some troubles were reported due mainly to aprons that were not precisely centered in the backdown area.

### MV *Bold Contender* Charter, 1975

Small-mesh modifications designed by McNeely were further tested in the fall of 1975 on the charter cruise of the MV *Bold Contender* under command of John Gonsalves. Operating from a small rubber-raft using face mask and snorkle, James Coe of the Southwest Fisheries Center observed the behavior of the animals and the net in the backdown area. Coe discovered that many animals thought to be laying dead at the bottom of the net were actually alive, and if enough time were allowed, these animals would surface for air and could be safely released. Coe would signal the captain when all live porpoise were out of the net and backdown could be ended. The net for these tests was hung with a double strip (11 fm deep) Medina panel, and a longer apron with a chute laced to its distal margin. All small-mesh webbing was 1¼-inch stretch mesh. This configuration developed a longer, gently inclined ramp in the region where the porpoises concentrated, and during backdown the decreased straining area of the small mesh created an increased flow of water that helped to "wash" the porpoises over the corkline. At the same time, a

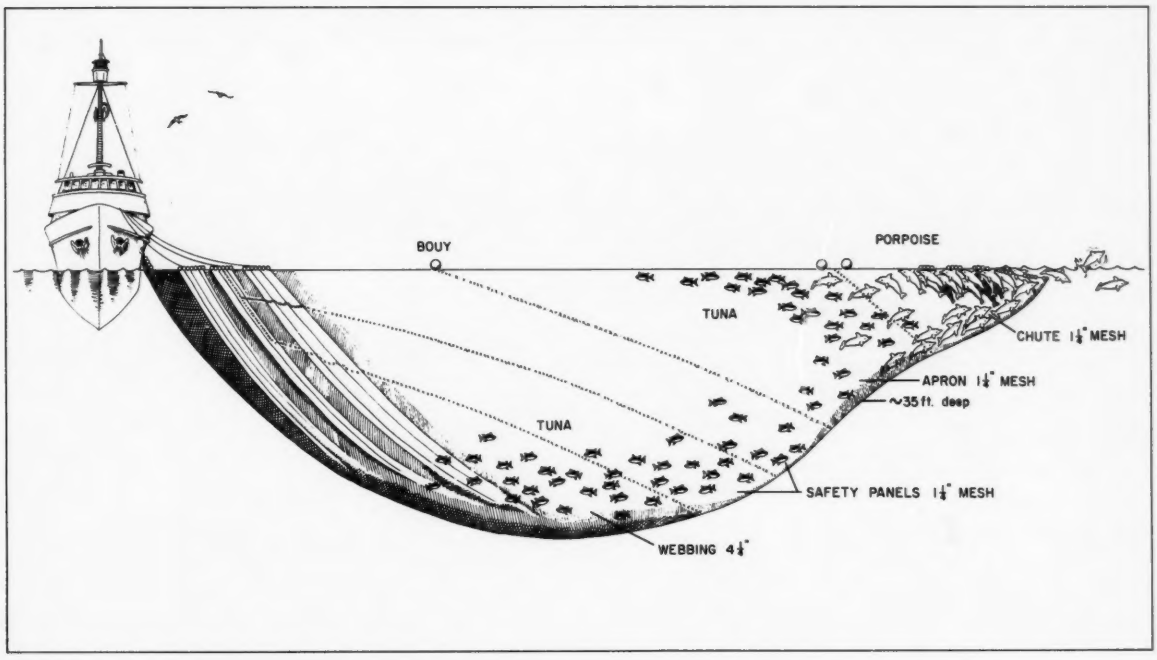



Figure 5.—Schematic cross-section of the apron-chute, double Medina panel, configuration in a tuna purse seine during backdown. Mesh sizes of the various components are indicated.

deep pocket was formed in an area in front of the Medina panel that tended to hold the tuna away from the backdown area (Fig. 5). This arrangement of small-mesh netting in conjunction with other devices and methods is now known as the "Bold Contender System" (Staff, Porpoise/Tuna Interaction Program, Oceanic Fisheries Resources Division, 1976). An extremely low porpoise mortality was recorded during this charter cruise.

### Major Field Tests, 1976

There was some doubt as to whether the success of the *Bold Contender* charter was mainly due to the apron and chute, to the extensive small-mesh Medina panel, or to the observer in the small rubber raft. However, as a result of these tests, NMFS and the newly formed tuna industry sponsored Porpoise Rescue Foundation inaugurated a major testing and evaluation program in 1976. As planned, 10 vessels would fish with a double-strip Medina panel and an apron and chute all hung from 1¼-inch stretch-mesh webbing, and another 10 seiners would fish with only a double strip, 1¼-inch Medina panel. Both sets of vessels were to use a face-mask equipped observer working from a small rubber raft. The vessels would also use the other aspects of the Bold Contender System and NMFS field technicians would accompany all vessels and record performance.

As the 1976 season progressed, some of the test trips were aborted due to Judge Charles Richey's court ruling on the validity of the permit to take porpoises issued by NMFS to the American Tunaboat Association, but at this writing most of these trips have been resumed and data are rapidly accumulating from approximately the full vessel complement.

Regardless of the final outcome relative to the apron and chute vs. the extended 1¼-inch Medina panels, it appears that the introduction of small-mesh netting will make a major contribution to further reductions of incidental porpoise mortality in tuna purse seines[1].

[1]While this manuscript was in review, preliminary results of the MV *Elizabeth C. J.* 1976 charter cruise became available. To obtain the cooperation of this modern seiner it was necessary to combine yellowfin tuna allotments for both gear work and behavioral research. The gear work was essentially a continuation of the "Bold Contender System" approach, and the net was equipped with an extensive Medina panel and modified apron hung from 1¼-inch mesh webbing. The results were extremely successful. During the cruise the *Elizabeth C. J.* made 45 sets on porpoise which took 917 tons of yellowfin tuna with only 15 porpoise being killed. Further, the majority of these animals were killed as a result of the behavioral research objectives rather than normal fishing operations. This record low kill rate was attributed to four factors: 1) a successful culmination of NMFS gear research under the direction of Richard McNeely; 2) the underwater observations of James Coe, who again worked from a rubber raft in the backdown area; 3) good environmental conditions; and 4) the skill and dedication of the vessel captain, Manuel Jorge, and his crew members. A full report on this cruise will be published in the next issue (39:6) of *Marine Fisheries Review*. The results of the behavioral research under the direction of Kenneth Norris will be reported elsewhere.

## ACKNOWLEDGMENTS

We are indebted to NMFS gear specialists, Richard McNeely and Jerry Jurkovich, and the members of the Porpoise/Tuna Interaction Program at the Southwest Fisheries Center for counsel and advise. We are also most grateful to the captains and crew members who cooperated in 1975 porpoise apron tests. Three fishermen, Harold Medina, Joseph Scafidi, and Julius Zolezzi, in particular have made major contributions to the development and introduction of small-mesh net modifications for porpoise safety. Frank Alverson, Vice President of Living Marine Resources, Inc., and August Felando, Director of the American Tunaboat Association, have provided or confirmed historic facts on the fishery. William Evans took the official U.S. Navy photographs of the *Gina Karen* backdown, and we are indebted to the captain of that vessel, Louis Romani, for his cooperation. Art work has been done by Kenneth Raymond and typing of the manuscript by Lorraine Prescott.

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MFR PAPER 1247

# Effect of Processing Variables on Storage Characteristics of Frozen Minced Alaska Pollock

D. MIYAUCHI, G. KUDO, and M. PATASHNIK

## INTRODUCTION

The ocean off Alaska contains one of the largest groundfish resources available to the U.S. industry. Yet these resources have been harvested almost exclusively by foreign fishermen, who have caught over 2 million metric tons of groundfish annually since 1971. Initially most of the catch was used for foreign consumption, but during the early 1970's increasing amounts of these catches entered the U.S. market to meet our growing demand for frozen fillets and fillet blocks. Much of the imported fish went to the institutional trade in which low price and uniform quality are essential. Foreign processors found production costs could be lowered through high flesh yields from mechanized methods of recovering minced flesh. This flesh was frozen into blocks and used for fish sticks and portions production.

The minced Alaska pollock, *Theragra chalcogramma*, blocks that were used in fish sticks and portions production in 1973 and 1974 were imported primarily from Japan and varied widely in quality. The primary defects were poor color and nonuniformity in appearance, ammoniacal odors, and tough or rubbery texture. The breading on the precooked fish sticks was often overly wet or "soggy" in places. As a result of these quality problems, the price of minced Alaska pollock blocks was drastically reduced and imports from Japan virtually stopped.

The raw flesh of freshly caught Alaska pollock has a bland neutral odor, but uniced fish develop a strong, over-powering surface or skin odor in less than 1 day; whereas iced fish gradually develop this odor in about a week, thus reducing acceptability as fresh fish (Okada and Noguchi, 1974). Trimethylamine oxide in the flesh of Alaska pollock, as well as other Gadoid family members, is converted enzymatically to dimethylamine and formic acid with accompanying deterioration in texture (Amano et al., 1963; Amano and Yamada, 1964a, 1964b). Thus, special handling procedures for Alaska pollock may be required to assure production of uniform high-quality blocks.

During this period when the world-wide demand for fish fillets and blocks was high and their prices were at their peak, the question was raised whether U.S. fishermen and processors might develop these fisheries off Alaska, improve product quality, lessen our growing dependence on foreign production, and thereby strengthen our own fishery economy. To provide information by which the opportunities for domestic utilization of Alaska groundfish could be evaluated, in the spring–summer of 1974 a joint industry–government venture carried out production fishing and processing trials (Anonymous, 1974[1]). The National Marine Fisheries Service's Northwest and Alaska Fisheries Center, Utilization Research Division, participated in two of the studies.

In the first study, various species of groundfish were held under different storage conditions on board the 295-foot stern trawler–processing vessel, *Royal Sea*. To determine the relative effectiveness of these different treatments, observations were made on the changes in quality of the fresh and frozen fish. The results of these tests will be reported in another paper[2].

In the second study, which is the subject of this paper, some handling and processing variables that might improve the textural and flavor characteristics and frozen storage life of minced Alaska pollock blocks were investigated. Variables included: preservation methods used to hold the fish prior to processing [in ice, slush ice, or refrigerated seawater (RSW)], effect of washing the minced flesh, particle size, and the addition of various ingredients—sodium chloride, sodium tripolyphosphate, and sugar. In earlier minced fish studies, some of the processing variables did improve the cold storage characteristics of minced black rockfish blocks (Miyauchi et al., 1975).

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[1]Anonymous. 1974. Preliminary results of an industry—government venture on Alaska groundfish. Processed rep., 72 p. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112.

[2]Nelson, R. W., and P. Hunter. In prep. Preservation and quality characteristics of Alaska bottomfish. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112.

## COMPARISON OF PRESERVATION METHODS

To determine the effect of the method of preservation of round fish on the quality and storage stability of the minced flesh, fish that were caught 23 May from the area south of Usof Bay, Unalaska Island, were held either in ice for 4–6 days or in either slush ice or RSW at 30°F for 5 days. Each lot of fish was headed and gutted, washed, and passed through the Bibun[3] flesh separator equipped with a drum having 5-mm holes and with the belt set at medium pressure. Approximately 1-pound quantities of minced flesh were packed into waxed frozen-food cartons, frozen aboard the *Royal Sea,* and shipped to Seattle where the initial examination for quality was conducted about 3 months after they were prepared. Additional examinations for quality differences were made after 6 and 12 months of storage at 0°F. At each examination, the frozen minced blocks were evaluated for appearance and were then cut, battered, breaded, and deep-fat fried at 360°F for 4 minutes for flavor and texture evaluation by a panel of 12 experienced judges.

The frozen minced blocks prepared from the iced fish were normal in appearance, but those prepared from fish held for 5 days either in slush ice or RSW had a slight-to-moderate greyish cast. This off-color was caused in part by pigmented particles sloughing off from the skin as the flesh was removed in the flesh-separating machine. The flavor and texture of the fish sticks from the various blocks were rated fair to good (Table 1). Sticks made from fish iced 4 days were the best; they were of good flavor and fair-to-good texture during the 12 months of storage at 0°F. In comparison, the sticks from the other three lots had lower flavor and texture scores. Statistical analysis of the scores for flavor and texture of each of the lots showed no significant changes resulting from storage of the block. Nevertheless, there was a slight declining trend in scores with increasing storage time.

## PROCESSING STUDIES

Alaska pollock caught on 5 August by the trawler *Anna Marie* at 54 fathoms on the Portlock Bank located south of the Kenai Peninsula were used. The fish were somewhat small, with about 80 percent of them being 12 to 14 inches long and weighing about 0.85 pounds each. The fish were iced within several hours after catching and unloaded the following day at a processing plant in Seward, Alaska.

### Minced Flesh Yield

In the plant the fish were washed, headed, gutted, split to remove the backbone by hand, washed again, and passed through the Bibun flesh separator as described in the previous section.

The "first-pass" minced flesh yield was 35.7 percent based on the weight of the whole fish. By passing the waste from the first-pass through the flesh-separator machine, an additional minced flesh yield of 6.0 percent was obtained. Partial removal of the belly wall that is lined with a black membrane and of the backbone with the adhering kidney and blood vessels before mechanical flesh separation resulted in less than maximum flesh recovery. In comparison, Okada and Noguchi (1974) reported that the edible part is about 40 percent of the weight of the fish. The "second-pass" flesh was much darker in color than the first-pass flesh and was considered unsuitable for making fish sticks and breaded portions; therefore only the first-pass minced flesh was used in the processing experiments.

### Effects of Washing Minced Pollock Flesh

Buyers of frozen fish blocks have indicated preference for blocks that are "white" or light-colored. Since our earlier studies showed that a single cold-water wash improved the color and frozen storage stability of minced black rockfish, this technique was tried with minced pollock.

#### *Preparation of Unwashed Minced Muscle Blocks (Controls)*

Approximately 1-pound quantities of the minced pollock muscle taken directly from the flesh separator were packed into waxed frozen-food cartons and frozen in a contact freezer at about −40°F to form our mini-block control samples.

#### *Washed Minced Muscle Blocks*

A portion of the minced muscle taken from the flesh separator was weighed in a close-knit nylon mesh bag and gently agitated for 10 minutes in chilled tap water (ratio of 5 parts by weight of water to 1 part by weight of minced muscle). The bag containing the fish–water slurry was suspended so as to permit the excess water to drain through the bag. Normally, draining for several hours will bring the weight of the washed muscle down to approximately 3 percent less than that of the muscle before washing. With 1-day iced pollock, however, it was necessary to apply weights on the bag to expedite the removal of the excess water from the minced muscle. The washed muscle was packed and frozen similar to the control sample.

#### *Results*

The frozen blocks that were made from washed minced muscle were definitely lighter in color than those made from unwashed flesh. In the initial examination 2 months after the blocks were prepared, no significant differences in texture were found between fish sticks made from washed and unwashed minced flesh (Table 2); however, the lack of flavor of the samples made from washed flesh resulted in a slightly lower flavor rating than that received by samples made from the unwashed minced flesh. In subsequent examination after 6 and 12 months of storage, 5 percent NaCl was added to the batter used on the washed flesh blocks to compensate for the flavor constituents lost by washing. This simple addition of salt to the breading material increased the flavor level to the point where there was essentially no difference between washed and unwashed blocks. Washing had no effect on the texture of the muscle fibers. Several judges, however, noted that the samples from the washed flesh were more moist and tender than those made from the unwashed flesh blocks. This reflects the higher moisture content of the washed blocks (average 85.75 percent) compared to that of the unwashed blocks (average 83.35 percent) (Table 3). The cook drip from the washed blocks was significantly higher than that of the unwashed blocks (Table 3). Based on these limited tests, the benefit of improved color gained from washing is questionable when weighed against the disadvantages of lower flesh yield and increased processing costs.

[3]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

### Effect of Minced Flesh Particle Size

Two lots of samples were prepared by passing unwashed and washed minced flesh through a plate grinder having 1.9-mm diameter holes, packaging, and freezing as previously described.

In comparing the frozen minced blocks made from 5-mm particle size and from the 1.9-mm particle size, the larger particles of dark flesh mixed in with the white flesh gave the coarse minced block a mottled appearance, whereas the 1.9-mm particle blocks were more uniform in appearance. Our sensory panel found no significant differences in flavor and texture of the fish sticks prepared from the 5-mm and 1.9-mm particle blocks (Table 2) throughout the 12-month storage test. Both lots were judged "fair" to "good" in flavor and texture. The drip losses were generally lower for the 1.9-mm blocks than for the 5-mm blocks (Table 3).

### Effect of Adding Ingredients

In our earlier studies, the addition of ingredients such as salt, sugar, and sodium tripolyphosphate improved the frozen storage stability, particularly texture, of frozen blocks of minced black rockfish. We tested this procedure on unwashed and washed minced pollock flesh by adding 1 percent NaCl, 1 percent sugar, and 0.15 percent sodium tripolyphosphate. The results of the sensory examination of fish sticks prepared from the various minced pollock blocks are presented in Table 4. In general, there was no statistically significant difference in flavor between blocks with or without added ingredients. With respect to texture, the blocks with the added ingredients had lower texture scores, especially after frozen storage of 6 months or more. Blocks with no added ingredients were described as stringy, fibrous, dry, and/or chewy. Those with added ingredients were described as rubbery and tough.

## DISCUSSION

Minced pollock flesh appears to have relatively good stability against the development of rancid flavors during frozen storage; on the other hand, it does not have a good positive flavor even when fresh. Minced pollock becomes dry, fibrous, and chewy during frozen storage. Work is needed to develop means of improving the flavor and texture of blocks to be used for further processing into sticks and portions.

The belly flaps of pollock are lined with a black membrane that will appear as black specks in the minced flesh if the flaps are not cut off before deboning. The kidney should be removed entirely, together with the spinal column, before deboning to avoid the discoloration of the minced flesh. In addition, the bits of kidney accelerate the flavor deterioration of the flesh during storage.

**Table 1.—Mean flavor and texture scores of fish sticks prepared from minced Alaska pollock blocks prepared from fish held in either ice, slush ice, or refrigerated seawater (RSW), and then stored up to 12 months at 0°F.**

| Method of holding fish | Flavor score after storage of | | | Texture score after storage of | | |
|---|---|---|---|---|---|---|
| | 3 mo | 6 mo | 12 mo | 3 mo | 6 mo | 12 mo |
| 4-day iced | [1]4.4 | 4.0 | 3.9 | 4.0 | 3.8 | 3.7 |
| 6-day iced | 3.8 | 3.6 | 3.8 | 3.5 | 3.3 | 3.4 |
| 5-day slush ice | 4.0 | 3.5 | 3.8 | 3.6 | 3.4 | 3.4 |
| 5-day RSW | 3.5 | 3.6 | 3.6 | 3.6 | 3.9 | 3.6 |

[1]Five-point rating scale: 5—very good; 4—good; 3—fair; 2—borderline; 1—poor.

**Table 2.—Mean flavor and texture scores of fish sticks prepared from minced Alaska pollock blocks prepared from washed or unwashed flesh, 5-mm or 1.9-mm particle size flesh and then stored up to 12 months at 0°F.**

| Sample treatment | Flavor score after storage of | | | Texture score after storage at | | |
|---|---|---|---|---|---|---|
| | 2 mo | 6 mo | 12 mo | 2 mo | 6 mo | 12 mo |
| Unwashed | [1]3.3 | 3.4 | 3.3 | 3.4 | 3.4 | 3.2 |
| Washed | 2.9 | 3.6 | 3.4 | 3.2 | 3.3 | 3.4 |
| 5-mm | 3.1 | 3.5 | 3.5 | 3.3 | 3.4 | 3.4 |
| 1.9-mm | 3.1 | 3.5 | 3.2 | 3.3 | 3.3 | 3.3 |

[1]Five-point rating scale: 5—very good; 4—good; 3—fair; 2—borderline; 1—poor.

**Table 3.—Effect of particle size and washing of minced flesh and of added ingredients on thaw drip (68 F)[1] and cook drip of minced Alaska pollock during storage at 0 F.**

| Sample treatment | Moisture content | Thaw drip | | Cook drip | |
|---|---|---|---|---|---|
| | | 2 mo | 12 mo | 2 mo | 12 mo |
| | % | % | % | % | % |
| Unwashed, 5-mm | 83.5 | 5.9 | 3.7 | 24.7 | 25.7 |
| Unwashed, 1.9-mm | 83.2 | 5.4 | 1.2 | 21.6 | 19.2 |
| Washed, 5-mm | 85.6 | 4.1 | 5.6 | 32.9 | 33.1 |
| Washed, 1.9-mm | 85.9 | 5.9 | 5.4 | 30.9 | 28.9 |
| Unwashed, 5-mm (control) | — | 4.6 | 2.3 | 24.4 | 24.6 |
| 1% NaCl | — | 3.4 | 0.8 | 17.3 | 23.2 |
| 0.15% NaTPP | — | 6.6 | 2.4 | 23.4 | 21.4 |
| 1% NaCl, 0.15% NaTPP | — | 4.1 | 1.2 | 18.6 | 23.3 |
| 1% NaCl, 0.15% NaTPP, 1% sugar | — | 3.6 | 1.8 | 17.9 | 21.2 |

[1]The amount of thaw drip at 34°F for all samples was negligible.

**Table 4.—Effect of adding food ingredients[1] to unwashed and washed minced Alaska pollock flesh on flavor and texture of fish sticks prepared from blocks after 3, 6, and 12 months of storage at 0°F.**

| Treatment | | | Flavor score after storage of | | | Texture score after storage of | | |
|---|---|---|---|---|---|---|---|---|
| | | | 3 mo | 6 mo | 12 mo | 3 mo | 6 mo | 12 mo |
| 4-day iced | Unwashed | No ingredients | [2]4.4 | 4.0 | 3.9 | 4.0 | 3.8 | 3.7 |
| | | Ingredients added | 3.7 | 3.6 | 3.7 | 3.7 | 3.0 | 2.1 |
| | Washed | No ingredients | 3.7 | 3.9 | 3.9 | 3.9 | 3.6 | 3.3 |
| | | Ingredients added | 4.2 | 3.8 | 3.9 | 4.0 | 3.5 | 2.9 |
| 6-day iced | Unwashed | No ingredients | 3.8 | 3.6 | 3.8 | 3.5 | 3.3 | 3.4 |
| | | Ingredients added | 3.7 | 3.5 | 3.6 | 3.5 | 2.8 | 2.3 |
| | Washed | No ingredients | 3.4 | 3.2 | 3.6 | 3.3 | 3.3 | 3.6 |
| | | Ingredients added | 3.7 | 4.0 | 3.6 | 3.6 | 3.4 | 3.2 |

[1]The following food ingredients added to minced flesh: 1% NaCl, 1% sugar, and 0.15% sodium tripolyphosphate.
[2]Five-point rating scale: 5—very good; 4—good; 3—fair; 2—borderline; 1—poor.

Washing of the minced flesh improves color but not flavor or texture. Washing therefore is not recommended because it is costly and unrewarding in terms of quality improvement.

## ALTERNATE USES

An alternate use for minced pollock blocks is as an extender in processed meat products. The bland flavor and stringy-tough texture of frozen minced pollock, which are negative characteristics in fish sticks, offer certain advantages when used as an extender in hamburger patties and sausage products (frankfurters, luncheon meats, etc.). Since light color of fish flesh is not important for this type of end use, undoubtedly a higher yield of minced pollock could be realized.

Several tests have been carried out to determine how well minced Alaska pollock muscle performs as partial replacers of the lean beef used as emulsifiers and nutritional protein sources in sausage products. This work has been done in cooperation with commercial sausage manufacturers, and fish muscle has been found by these food processors to be eminently satisfactory in terms of function. Products made include frankfurters, bologna, and luncheon meats. Texture, flavor, yield, and resistance to spoilage have all been found to be satisfactory when 10 to 15 percent of the lean-meat portion of the product was replaced by an equal weight of fish flesh. Frankfurters were prepared in which the lean beef was replaced at various levels with pollock flesh that had been stored for 1 year at 0°F plus an additional 10 months at −20°F. The results of the taste tests (Table 5) show that the flavor scores of frankfurters extended with up to 15 percent pollock muscle were comparable to the flavor scores of the regular frankfurters.

**Table 5.—Comparison of mean flavor scores of frankfurters in which lean beef is replaced by Alaska pollock muscle at various levels with those of regular frankfurters.**

| Replacement level with pollock % | Flavor score |
|---|---|
| 0 | [1]4.2 |
| 5 | 4.3 |
| 0 | 4.4 |
| 10 | 4.2 |
| 0 | 4.3 |
| 15 | 4.2 |

[1]Five-point rating scale: 5—very good; 4—good; 3—fair; 2—borderline; 1—poor.

**Table 6.—Mean flavor and texture scores of patties in which the ground beef is replaced by 10 percent Alaska pollock and 10 percent soy protein.**

| Composition of patties | Flavor score | Texture score |
|---|---|---|
| 100% beef | [1]3.8 | 3.8 |
| 10% pollock | 3.6 | 3.8 |
| 100% beef | 4.0 | 3.8 |
| 10% pollock, 10% soy protein | 3.4 | 3.9 |

[1]Five-point rating scale: 5—very good; 4—good; 3—fair; 2—borderline; 1—poor.

Several tests were run in which minced fish muscle was added to meat patties to determine the acceptability of such a product. In a typical test, 10 percent of ground beef was replaced with an equal weight of minced Alaska pollock or 20 percent of ground beef was replaced with 10 percent minced pollock and 10 percent soy isolate. Most panelists found either no difference in flavor or only a slight reduction in beef flavor when pollock alone or pollock and soy protein replaced some of the beef (Table 6). Differences in texture were not significant, but some panelists indicated a preference for the samples containing fish because they were considered to be more tender. The results of these tests indicate that Alaska pollock of initial good quality may be frozen and held at 0°F for at least 1 year for use as a meat replacer at the 10 percent level in beef patties.

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MFR PAPER 1248

# Response of Costs and Returns to Alternative Feed Prices and Conversions in Aquaculture Systems

J. E. EASLEY, Jr.

## INTRODUCTION

Aquaculture, the grow-out of fish and shellfish in managed systems, has received increasing attention in recent years as an alternative source of fish[1]. Several species are currently cultured in the United States, the most notable being catfish and trout (Madewell, 1971; Klontz and King, 1975). Many argue that fish will supply an increasing share of the world's protein while aquaculture will supply an increasing share of fish available for consumption (e.g. Ronsivalli, 1976). Whether this transpires will depend in part on production efficiency in culture systems. The purpose of this paper is to examine the effects of changes in feed conversion ratios and feed prices on costs and returns in trout production.

In discussions with North Carolina mountain trout growers, the price of feed and additional marketing outlets were cited as two of the major problems encountered. While the individual grower cannot affect feed prices, he does have some control over the feed conversion ratio (pounds of feed per pound of fish-weight gained). Hence an opportunity to reduce costs is available through improved management practices. The following trout feed conversion ratios are among those reported in the literature: 1.29:1 (Hill, Chesness, and Brown, 1972:374); 1.27:1 (Brown, Hill, and Chesness, 1974:5); and 1.54 (Collins, 1972:5).

A feed conversion ratio of 2.0:1 was often mentioned as a general guide in conversations with growers. The evidence suggests that a feed conversion ratio of 2.0:1 can be reduced significantly through more careful monitoring of fish weight and feeding practices. Feed adjustments resulting from changes in fish size and/or water temperature over the growth cycle can reduce the final feed conversion ratio attained. These adjustments can be refined by sampling fish size and water temperature (Hill, Chesness, and Brown, 1972:369–373). The effects on costs and returns are estimated for alternative feed conversion ratios and compared with two different feed prices as a reference.

Budgets have been developed for three alternative raceway systems, with an initial 2.0:1 feed conversion ratio assumed (Easley, 1976). Alternative feed conversion ratios are analyzed and compared with the different feed prices through their impacts on unit costs and the internal rate of return to investment in the facilities. The internal rate of return is included as it allows the estimation of the impact of a potentially permanent reduction in costs over the life of a project. It is computed from income and expense cash flows projected over the assumed life of the raceway systems; hence it differs from the simple rate of return on investment, usually computed on the basis of one year's net return.

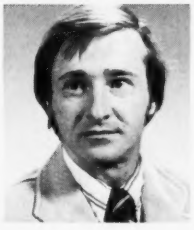

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**Table 1.—Trout production budgets for three raceway systems, 1975.**

| Item | Unit production size I | II | III |
|---|---|---|---|
| Pounds harvested | 25,000 | 55,000 | 120,000 |
| Total facilities investment | $27,039 | $56,795 | $112,664 |
| Overhead costs[1] | 3,586 | 7,475 | 14,756 |
| Operating costs | | | |
| Fingerlings[2] | 8,900 | 19,560 | 42,660 |
| Feed[3] | 6,650 | 14,631 | 31,924 |
| Labor[4] | 1,625 | 3,575 | 7,800 |
| Chemicals[5] | 175 | 385 | 840 |
| Utilities[5] | 1,000 | 1,500 | 3,000 |
| Interest on operating capital[6] | 1,026 | 2,225 | 4,840 |
| Total operating costs | 19,376 | 41,876 | 91,064 |
| Total overhead & operating costs | 22,962 | 49,351 | 105,820 |
| Costs/lb harvested | 0.92 | 0.90 | 0.88 |
| Overhead | (0.14) | (0.14) | (0.12) |
| Operating | (0.78) | (0.76) | (0.76) |

[1]Includes: 1) amortization of raceways, building, and distribution/collection boxes at 9 percent for 25 years; pipes and miscellaneous construction and handling equipment at 9 percent for 10 years; 2) assumed maintenance of 0.5 percent per year of investment in facilities; and 3) estimated yearly taxes and insurance of 2 percent of total investment in facilities.
[2]Fingerlings are 5- to 6-inch trout: a 10-percent mortality rate, 9 months' grow-out, and a price of $200 per 1,000 are assumed.
[3]Estimated with a 2.0:1 feed conversion ratio and a price of $300 per ton.
[4]Hours of labor estimated from Brown, Hill, and Chesness (1974), with $2.00 minimum wage applicable to agricultural labor as of January 1976 employed to obtain costs.
[5]Estimated.
[6]Interest on operating capital assumed to be 9 percent of the operating capital estimate of 0.75 (fingerling cost) +0.5 (cost of feed + labor + chemicals + utilities). Interest on operating capital computed at 9 percent for 9 months is equivalent to a 12 percent annual rate.

## GROW-OUT SYSTEMS

Investment and operating costs are based on information obtained in 1975 from growers and specialists working with the industry (Easley, 1976). The total investment in each of the three concrete raceway systems and assumed harvest poundage is shown in Table 1. Overhead costs are based on an assumed 25-year life of the raceways and building; 10 years for pipes and miscellaneous construction[2].

[1]A recent example underscoring interest in aquaculture was the Workshop to Identify Aquaculture Economics Research Needs held 23 April 1976 (Smith and Roberts, 1976).

[2]The decline in overhead costs per pound is largely attributable to the estimates included for the utility buildings and miscellaneous construction. No relationship between output and this construction emerged from the survey, but the estimates themselves account for the apparent economies. The same holds true for the reduction in operating costs between systems I and II, where estimates for utilities account for the reduced operating costs.

Neither land nor management costs are included in Table 1; the net return is viewed as a return to management and land. Imputing costs to these, especially management, is difficult as a result of their variability. At the same time, it is not crucial to the analysis: we are interested in the effect of feed usage and price fluctuations on the net return regardless of whether that return is distributed between one or more factors of production.

Note that the variable input, feed, makes up 34–35 percent of the total operating costs. While the fingerling outlay is larger, it may not be as amenable to further reductions as feed. Fingerling outlays could be reduced by reducing mortality rates; however, because of the risks associated with spreading disease in intensive culture systems, the mortality rate is perhaps currently scrutinized more carefully than feed usage.

## EFFECTS OF ALTERNATIVE FEED CONVERSION RATIOS AND PRICES ON UNIT COSTS

Using Table 1 as a reference point, we now turn to the effects on unit costs of a reduction in the feed conversion ratio and in the feed price. An alternative feed price of \$250 per ton is selected, while the feed conversion ratio assumed is varied from 2.0:1 to 1.5:1 by tenths. Table 2 summarizes these results for unit operating costs. Though the assumed grow-out period is 9 months, a 1-year accounting period is employed.

The \$50 per ton reduction in the price of feed, for any given feed conversion ratio, lowers unit operating costs \$0.04–\$0.05 per harvested pound in system I, and \$0.03–\$0.05 per pound in systems II and III. The \$50 per ton reduction in the price of feed is a substantial one, representing a 16.7 percent reduction (as a percent of the original feed price). On the other hand, comparable reductions in unit costs could be achieved by reducing the feed conversion ratio by approximately 0.3 pounds in all three systems. For example, under a 2.0 conversion in system I at the higher feed price, unit operating costs are \$0.78. Unit costs drop to \$0.73 at a feed price of \$250 per ton. However, at the higher feed price of \$300 per ton, the same reduction in unit costs could be achieved by lowering the feed conversion ratio to 1.7:1. A 0.2 pound change in the feed conversion ratio lowers unit operating costs by either \$0.02 or \$0.03, depending upon the system, feed price, and original feed conversion ratio. Hence, improved management practices in feeding could reduce costs considerably with small or negligible increases in labor required to periodically sample fish sizes and growth rates. An example is hypothesized below.

**Table 2.—Unit operating costs for alternative feed prices and conversion ratios.**

| Feed Price (ton) | System[2] | Feed conversion[1] 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 |
|---|---|---|---|---|---|---|---|
| | | Cents | | | | | |
| $300 | I | 78 | 76 | 75 | 73 | 72 | 71 |
| 250 | I | 73 | 72 | 71 | 69 | 68 | 67 |
| 300 | II | 76 | 75 | 73 | 72 | 71 | 69 |
| 250 | II | 72 | 70 | 69 | 68 | 67 | 66 |
| 300 | III | 76 | 75 | 73 | 72 | 70 | 69 |
| 250 | III | 71 | 70 | 69 | 68 | 67 | 65 |

[1]Pounds of feed per pound of net weight gained. Note: Unit overhead costs are 14 cents in Systems I and II, 12 cents in System III.
[2]Systems same as those reported in Table 1.

Since feed consumption of trout is dependent on fish size and water temperature, both should be sampled throughout the growth cycle. Adjustments in feed can then be made utilizing standard feed tables relating feed as a percent of body weight to fish size and water temperature. Weekly feed adjustments have been reported based on fish samples and expected weight gain, with water temperature controlled in a recirculating system (Hill, Chesness, and Brown, 1972:369–373). Fluctuations in water temperatures from stream sources increase the importance of such sampling. One might experiment with the frequency of sampling, however; at least monthly would probably be desirable as both fish size and water temperatures can change significantly over this length of time[3].

To gain some understanding of the potential magnitude of net cost savings (reduced feed costs, increased labor costs) from improved feeding practices, the following example is hypothesized. Assumed are a 9-month grow-out period, monthly sampling, increased time required to sample of 20 minutes per raceway, and a resulting reduction in the feed conversion of 2.0 to 1.9. Reductions in feed outlays at feed price of \$300 per ton for systems I, II, and III are \$333, \$731, and \$1,596, respectively. Labor outlays would be increased in the three systems by \$43, \$101, and \$213. Net cost savings (ignoring small changes in interest on operating capital) would be \$290, \$630, and \$1,383. While the hypothesized reduction in the feed conversion ratio may be overly optimistic, net cost savings are substantial[4].

[3]Monitoring fish growth by sampling raises the question of how large a sample to take. A technique is available for estimating sample size when the population variance is unknown (Steele and Torrie, 1960:86–87).

## EFFECTS OF ALTERNATIVE FEED CONVERSION RATIOS AND PRICES ON RATES OF RETURN

Changes in unit operating costs are important barometers of profitability; however, they do not fully illustrate the impact of potentially permanent changes in costs on net revenue. To incorporate the effects on profitability over time of a reduction in the feed conversion ratio, internal rates of return on investment are computed for the same feed prices and conversion ratios shown in Table 2. These were estimated by a computer program from projected cash flows over the assumed 25-year life of the raceways.

Several assumptions were necessary to develop the cash flows. First, in order to generate revenues, a product price of \$0.95 per pound (live weight) was assumed. This price was selected because it is slightly above the highest total unit costs computed and in the range of prices received by growers in 1975. Revenues were assumed to begin in the second year and continuing through year 25, with salvage of equipment and land (valued at \$2,000 per acre) included in the final year[5].

The cost or outlay stream is assumed to begin the first year with the investment in facilities. A land value (at \$2,000 per acre) is included as it represents part of the initial

[4]The results suggest perhaps that biologists and economists should more closely examine the tradeoffs between labor requirements in feeding and growth responses to feed. Along the same lines, could more selective grading based on growth rates reduce total feed requirements? What are additional costs with these refinements? Answers to these types of questions might well allow further improvements in feed conversion ratios. While much work has been done with feed response, little has been done in correlating these responses to possible changes in costs (other than feed) and rates of return. Possible improvements in expected rates of return are important to commercial attempts at culturing new species as well as existing ones.

[5]Salvage values (estimated at book value using simple straight-line depreciation) may be understated if the raceways in fact have a longer productive life than the 25 years assumed. If this is the case, the rates of return would be somewhat higher than those reported. However, the emphasis is on comparisons of rates and not the absolute levels.

outlay[6]. Beyond the first year, actual outlays by year consist of the following: 1) operating and overhead expenses computed using Table 1 as a base and incorporating the feed prices and conversion ratios shown in Table 2; 2) replacement of equipment at succeeding 10-year intervals; and 3) estimated income tax payments. Tax payments were estimated using an assumed, simplifying tax schedule and an investment tax credit of 10 percent with a 3-year carryover[7].

Table 3 presents the internal rates of return computed from the cash flows. The rates exhibit a similar pattern to that in Table 2; they increase for a reduction in feed price and for lower feed conversion ratios. Note that the increase in the rate of return is smaller for a reduction in the price of feed, at the lower feed conversion ratios. This is true for any one of the three systems. There are two reasons for this pattern. First, at the lower feed conversion ratio, less feed is used, hence a given change in the price of feed has less impact. Second, at successively lower feed conversion ratios, taxes take a proportionately larger share of an increase in net profits that results from a decrease in the price of feed.

**Table 3.—Internal rates of return.**

| Feed price (ton) | System[2] | Feed conversion[1] 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 |
|---|---|---|---|---|---|---|---|
| | | *Percent* | | | | | |
| $300 | I | 7.9 | 9.2 | 10.3 | 11.2 | 12.2 | 13.2 |
| 250 | I | 11.6 | 12.4 | 13.2 | 14.0 | 14.8 | 15.6 |
| 300 | II | 9.9 | 11.0 | 12.1 | 13.1 | 14.1 | 14.7 |
| 250 | Ii | 13.5 | 14.3 | 14.7 | 15.5 | 16.4 | 17.2 |
| 300 | III | 11.7 | 12.9 | 14.0 | 15.1 | 16.2 | 17.2' |
| 250 | III | 15.5 | 16.2 | 17.2 | 18.1 | 18.0 | 18.8 |

[1]Pounds of feed per pound of net weight gained.
[2]Systems same as those reported in Table 1.

The rate of return shows some interesting patterns in moving to lower feed conversion ratios. A reduction in the feed conversion ratio of approximately 0.3 pounds has an effect comparable to the 16.7 percent decrease in the price of feed. Note also that the rates increase more at the higher feed prices than at the lower one for given reductions in the feed conversion ratios. This is not surprising.

The pattern of rates should furnish growers (and educational specialists working with them) some additional incentive to feed more efficiently. Not only do profits and rates of return increase, variations in net returns are also cushioned somewhat from fluctuations in feed prices.

[6]No land appreciation or product-price/cost inflation if assumed as the primary concern is to isolate the effects of the different cost conditions on the rate of return.

[7]Taxes were computed directly from the net profits of the trout enterprise. Assuming that most operations would be individually owned, the tax rates applied may appear low compared to Federal rates; however, personal deductions and exemptions have not been taken into consideration. Hence, rates applied directly to net profits for computing taxes that would be filed under a sole proprietorship status would be lower to attain comparable taxes. The assumed tax rates (percent of net business income) by business income are as follows: $10,000 or less, 10 percent; $10,001–15,000, 15 percent; $15,001–25,000, 20 percent; $25,001–40,000, 25 percent; Greater than $40,000, 30 percent.


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MFR PAPER 1249

# The Atlantic Coast Surf Clam Fishery—1974

Ropes Ward

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*ABSTRACT–The 1974 surf clam fishery produced landings of 96.1 million pounds of meats, 14.8 million pounds more than in 1973. Landings at Virginia ports were 34 percent higher than in 1973 and amounted to over half of the U.S. total. An increase in landings at Atlantic City, N.J., contributed substantially to an increase in New Jersey landings and other ports showed more moderate gains or losses.*

## INTRODUCTION

Landings of surf clams, *Spisula solidissima,* along the Middle Atlantic Bight have steadily increased from the beginning of the modern-day fishery in 1945 until today. This resource supplies most of the meats for clam products in the United States. A summary of annual reports for 1965–69, Ropes (1972), indicated that surf clams provided meats for more than half of the U.S. clam products during the 5-year period. Annual reports for 1970–73 documented changes in landings, areas fished, and fleet activities (Ropes and Barker, 1972; Ropes, Barker, and Ward, 1972, 1975; Ropes, Merrill, and Ward, 1975). These and the present report indicate the sharp increase in the utilization of the surf clam resource. In 1974, for example, surf clams supplied 82 percent (by weight) of the total production of clam meats in the United States, an increase of 2 percent over that reported for 1973. Most of the increase was from beds off the Virginia coast. This report compares landings at Virginia, Maryland, and New Jersey ports.

## INFORMATION SOURCE

Landings data in the Middle Atlantic Bight were supplied by the Division of Statistics and Market News, National Marine Fisheries Service, NOAA. Landings by vessel are generally obtainable at each port from New York through Virginia.

Interviews by port samplers provided specific information on fishing areas, catch, and effort at Point Pleasant, N.J., and in Maryland and Virginia. No interview records were obtained for vessels fishing off New York, Atlantic City and Cape May-Wildwood, N.J., and Delaware, but from personal communications with industry representatives and vessel captains, it appears that no significant new fishing areas were added to those reported for 1973.

## FLEET OPERATIONS AND LANDINGS BY AREA

The number of vessels in the surf clam fleet in 1973 and 1974 and the landings by area are presented in Table 1. In 1974 a total of 98 vessels, as in 1973, made up the fishing fleet in the Middle Atlantic Bight. The Virginia fleet increased by 11 to 32 vessels. Four vessels were based at Chincoteague, 5 at Oyster, 3 at Kiptopeke, 19 at Cape Charles, and 1 at Little Creek. The Division of Statistics and Market News observed that as many as 42 vessels used the Virginia ports at various times. The additional 10 vessels were migrants to the area from more northern ports.

The Maryland fleet consisted of 13 vessels—4 less than in 1973. Three very efficient vessels landed their catch in Delaware, although their home port was Cape May-Wildwood. A total of 44 vessels comprised the New Jersey fleet. Twenty-two vessels were based at Cape May-Wildwood—8 fewer than in 1973; 11 at Point Pleasant—a decrease of 2; and 3 vessels shifted to Atlantic City to increase that fleet to 11. The New York fleet, based mostly at

**Table 1.—Surf clam vessels and landings by area (1973–74).**

| Area | Number of vessels | | Landings in millions of lb | |
|---|---|---|---|---|
| | 1973 | 1974 | 1973 | 1974 |
| Chincoteague to Norfolk, Va. | [1]21 | 32 | 43.3 | 58.2 |
| Cape May–Wildwood, N.J. | 30 | 22 | 12.5 | 12.6 |
| Atlantic City, N.J. | 8 | 11 | 4.7 | 6.4 |
| Lewes, Del. | 2 | 3 | 6.6 | 5.8 |
| Ocean City, Md. | [1]17 | [1]13 | 7.5 | 5.4 |
| Long Island, N.Y. | [3]7 | [3]6 | 3.2 | 3.8 |
| Point Pleasant, N.J. | [2]13 | [2]11 | 4.1 | 3.5 |
| Total | 98 | 98 | [4]81.9 | [5]95.7 |

[1]Includes one part-time clammer.
[2]Includes one bait clam vessel.
[3]Includes two bait clam vessels.
[4]Total is less 0.338 million pounds of bait.
[5]Total is less 0.250 million pounds of bait.

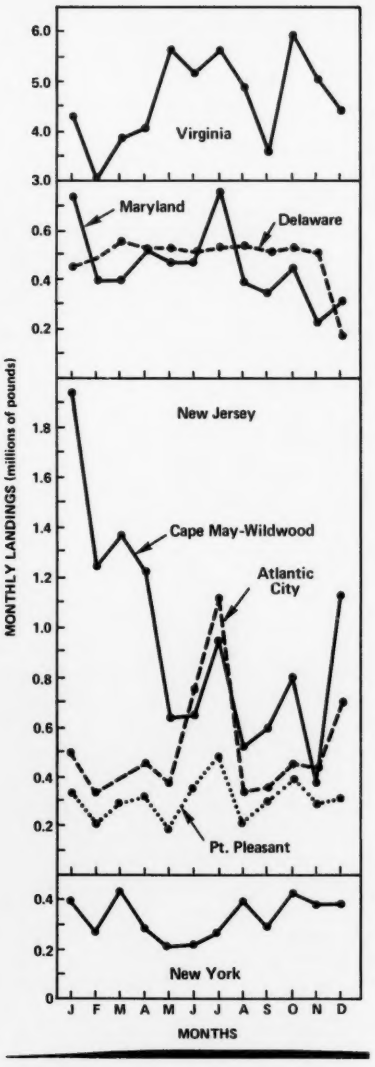


Figure 1.—Monthly landings of surf clams at ports in Virginia, Maryland, Delaware, New Jersey, and New York—1974.

Freeport, Long Island, decreased by 1 to a total of 6 vessels. Eight vessels quit clamming, 2 sank, and 10 new vessels were added to the total fleet in 1974. This resulted in no net change in the number of vessels.

Landings of 96.0 million pounds of meats were 14.8 million pounds (18 percent) higher than in 1973 (Table 1). Virginia landings increased from 43.3 to 58.2 million pounds, a total of 14.9 million pounds (34 percent) over those reported for 1973. Monthly catches ranged from 3.1 to 6.0 million pounds and averaged 4.6 million pounds (Fig. 1). Maryland landings of 5.4 million pounds were lower than in 1973 by 28 percent (2.1 million pounds). Monthly catches ranged from 0.2 to 0.8 million pounds and averaged 0.5 million pounds. Delaware landings of 5.8 million pounds were 0.8 million pounds lower than in 1973; monthly catches ranged from 0.2 to 0.6 million pounds and averaged 0.5 million pounds. New Jersey landings of 22.5 million pounds were 1.2 million pounds (6 percent) higher than in 1973. Ports of landing were at Cape May-Wildwood, Point Pleasant, and Atlantic City. Landings at Cape May-Wildwood were 0.1 million pounds higher than in 1973. This port has supplied more than half the New Jersey landings since 1967 and its contribution was 56 percent (12.6 million pounds) in 1974. Monthly catches were from 0.4 to 2.1 million pounds, averaging 1.1 million pounds. Vessels at Point Pleasant landed 3.5 million pounds. The decrease at this port was 15 percent (0.6 million pounds), averaging 0.3 million pounds. Vessels at Atlantic City, however, landed 6.4 million pounds, a 36 percent (1.7-million pound) increase over 1973. Monthly landings were from 0.3 to 1.3 million pounds and averaged 0.5 million pounds. The increase at Atlantic City more than compensated for the lower landings at Point Pleasant and contributed to the increase in total New Jersey landings. New York landings of 3.8 million pounds were 0.6 million pounds higher than in 1973. Monthly landings were from 0.2 to 0.4 million pounds, averaging 0.3 million pounds.

In summary, Virginia landings were 61 percent of the 1974 total—New Jersey 23 percent, Maryland 6 percent, Delaware 6 percent, and New York 4 percent. By contrast, 1973 landings by the respective states were 53 percent, 26 percent, 9 percent, 8 percent, and 4 percent.

## FISHING STATISTICS FROM INTERVIEWS

Interviews were obtained from vessel captains monthly throughout 1974 at Oyster, Kiptopeke, and Cape Charles, Va., and twice each month at Ocean City, Md. This activity resulted in 162 and 230 interviews for the respective states. The Division of Statistics, National Marine Fisheries Service, NOAA, provided 128 interviews for the months of April, June, July, and August in 1974 at Point Pleasant, N.J. The records derived from these interviews included the following: locations of vessel fishing operations, bushels of clams taken during the fishing trip, depths fished, hours spent fishing, and size composition of the catch.

Figure 2 shows 2,250 square nautical miles of ocean with intensity of vessel operations plotted on 5- × 5-nautical-mile areas. Vessels from Virginia fished in 21 of the southernmost areas; those from Maryland fished in 49 off the Delmarva Peninsula; and those from New Jersey fished in 20 of the northernmost areas. From 1 to 46 vessels operated in an area during the sampling period. The average number of trips per area was 5, or 0.2 trip per square mile. As a scale of intensity of fishing, <0.1 trip per square mile (1-2 trips per area) indicated light fishing activity, 0.1 to 0.6 trip per square mile (3-15 trips per area) moderate fishing activity, >0.6 trip per square mile (16+ trips per area) heavy fishing activity. The Virginia fleet concentrated in a 525-square-mile area, fished most intensely in a 75-square-mile area, moderately in a 225-square-mile area, and lightly in a 225-square-mile area. Maryland vessels were distributed in a 1,225-square-mile area, fished most intensely in a 75-square-mile area, moderately in a 525-square-mile area, and lightly in a 625-square-mile area. New Jersey vessels concentrated in a 500-square-mile area, fished most intensely in a 25-square-mile area, moderately in a 300-square-mile area, and lightly in a 175-square-mile area.

Vessels interviewed from Virginia fished at depths of 10.7 to 30.5 meters (35 to 100 feet), averaging 20.1 meters (66 feet); from Maryland at depths of 9.1 to 35.1 meters (30 to 115 feet), averaging 20.7 meters (68 feet); and from New Jersey at depths of 12.2 to 33.5 meters (40 to 110 feet), averaging 22.3 meters (73 feet). Catch rates for Virginia, Maryland, and New Jersey are shown in Figure 3. In Virginia catch rates of more than 200 bushels per hour were reported at 2 fishing areas, 100 to 199 bushels per hour at 5, 50 to 99 bushels per hour at 12, and 49 bushels or less at 2; the mean catch per hour in any one area ranged from 8 to 682 bushels (136 to 11,594 pounds). In Maryland the catch rates in 17 areas averaged 25 to 49 bushels per hour and were less than 25 bushels in the remaining 32 areas. The mean

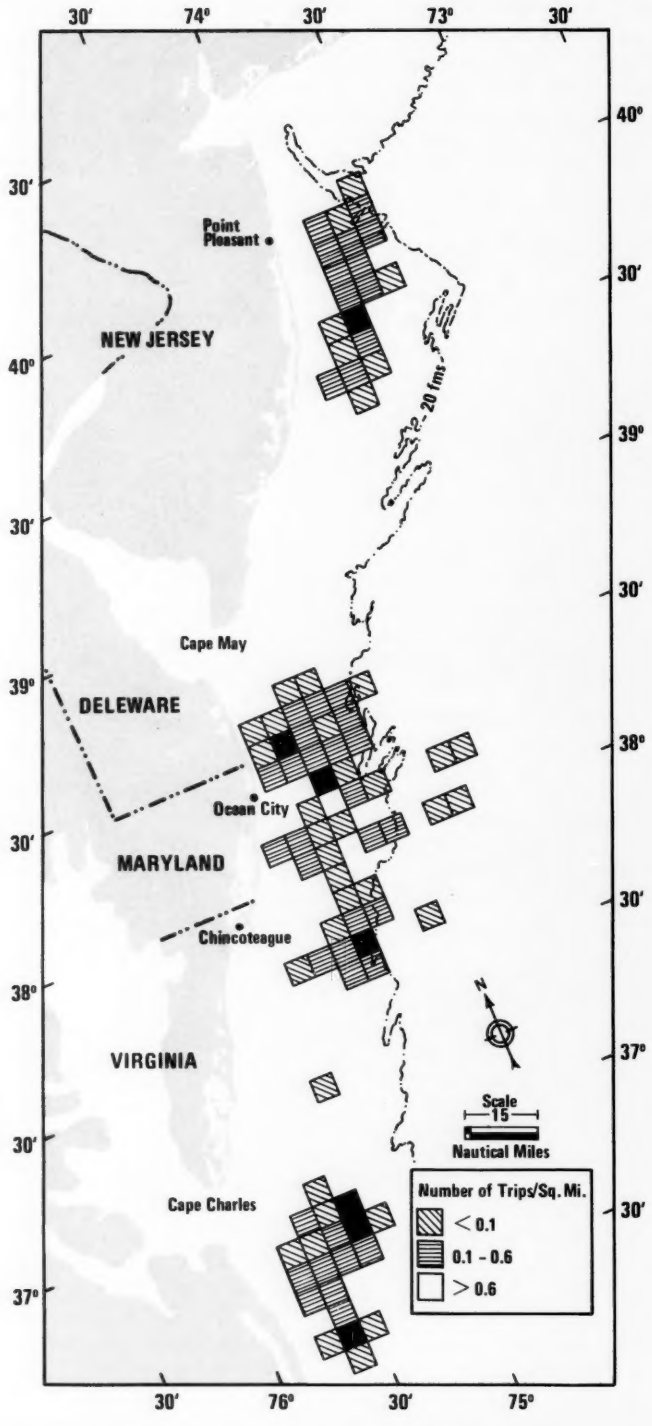


Figure 2.—The area and intensity of surf clam fishing by the Point Pleasant, N.J., Maryland, and Virginia fleet in 1974 (based on 520 interviews).

catch per hour in any one area ranged from 3 to 60 bushels (51 to 1,020 pounds). In New Jersey the catch rate in 5 areas averaged 25 to 49 bushels per hour; in the remaining 15 areas the catch rate averaged less than 25 bushels per hour. The mean catch per hour in any one area ranged from 6 to 42 bushels (102 to 714 pounds).

Figure 4 shows the mean shell lengths to be higher in New Jersey and Maryland than in Virginia. The clams in all New Jersey fishing areas averaged over 170 mm (6.7 inches). In Maryland the mean shell length from 4 areas was over 170 mm, from 133 to 170 mm (5.2 inches to 6.7 inches) in 44 areas, and less than 133 mm (5.2 inches) in 1 area. In Virginia mean clam size in 14 areas ranged from 133 to 170 mm and in 7 areas was less than 133 mm.

In Virginia continuous fishing time trip effort for the vessels interviewed ranged from 2.5 to 30 hours; monthly averages were 6.0 to 12.3 hours (Fig. 5); and the annual average was 8.9 hours per trip. Landings per trip were 23 to 3,700 bushels (391 to 62,900 pounds of meats), averaging 1,189 bushels (20,213 pounds). Monthly mean catch rates per hour ranged from 104 bushels (1,768 pounds) to 228 bushels (3,876 pounds), averaging 161 bushels (2,737 pounds), up 41 bushels (697 pounds) from 1973. Low trip landings and effort, as in earlier years, were often the result of gear breakdown which curtailed normal fishing operations. Lengths of clams ranged from 97 to 188 mm (3.8 to 7.4 inches), monthly mean lengths ranged from 121 to 138 mm (4.8 to 5.4 inches), averaging 132 mm (5.2 inches), down 3 mm (0.1 inches) from 1973.

In Maryland day trip effort for the vessels interviewed ranged from 3 to 14 hours, monthly averages ranged from 5.6 to 10.1 hours (Fig. 5), and the annual average was 8.1 hours. Landings per trip were 17 to 448 bushels (289 to 7,616 pounds of meats), averaging 182 bushels (3,094 pounds). Monthly mean catch rates per hour were 18 bushels (306 pounds) to 37 bushels (629 pounds), averaging 23 bushels (319 pounds), up 1 bushel (17 pounds) from 1973. Lengths of clams ranged from 106 to 192 mm (4.2 to 7.6 inches), averaging 160 mm (6.3 inches). Monthly mean lengths were consistently 150 mm or higher (150 to 169 mm or 5.7 to 6.7 inches), indicating most clams were taken from offshore beds.

This fleet averaged 0.3 more hours of fishing time per trip in 1974 than 1973 and concentrated on offshore beds. Fairly stable catches resulted from fishing an area twice as large as that of the fleets in New Jersey or Virginia.

In New Jersey, day trip effort for the vessels interviewed at Point Pleasant ranged from 2.5 to 14 hours; averages for the months of April, June, July, and August ranged from 8.5 to 9.4 hours (Fig. 5), and the four month average was 9.1 hours. Landings per trip were 25 to 370 bushels (425 to 6,290 pounds of meats), averaging 192 bushels (3,264 pounds). Mean monthly catch rates per hour were 18 to 24 bushels (306 to 408 pounds), averaging 22 bushels (374 pounds). Lengths of clams ranged from 145 to 226 mm (5.7 to 8.9 inches), averaging 186 mm (7.3 inches). Monthly mean lengths were all 150 mm or higher (167 to 189 mm or 6.6 to 7.4 inches). These catches were all from offshore beds.

## STATUS OF TRENDS OF THE FISHERY

The 96.1 million pounds of surf clam meats landed in 1974 is the highest annual total to date. This resulted from an increase in effort on beds off the Virginia coast. A similar increase in 1973 was reported by Ropes, Merrill, and Ward (1975) to be in response to 1) increased demand and 2) lower landings from the coastal area of Maine through Virginia of other major commercial clams, such as the hard clam (*Mercenaria mercenaria*), soft clam (*Mya arenaria*), and ocean quahog (*Arctica islandica*). Landings of these species have been low since 1972. In 1974, landings of the three species amounted to 21.2 million pounds of meats or 18 percent of the 117.3 million pounds of clam meats harvested from the total resource. It is clear that the surf clam resource is sustaining the bulk of the demand for clam products in the United States.

A larger resident fleet occupied Virginia ports in 1974 than 1973 (32 vs 21), but the number of migrant vessels was smaller (10 vs 20) and, in all, 43 percent of the total surf clam fleet fished Virginia beds in the respective years. Interview records indicated landings per trip increased from an average of 956 bushels (16,252 pounds of meats) in 1973 to 1,189 bushels (20,213 pounds) in 1974 and the monthly mean catch rate per

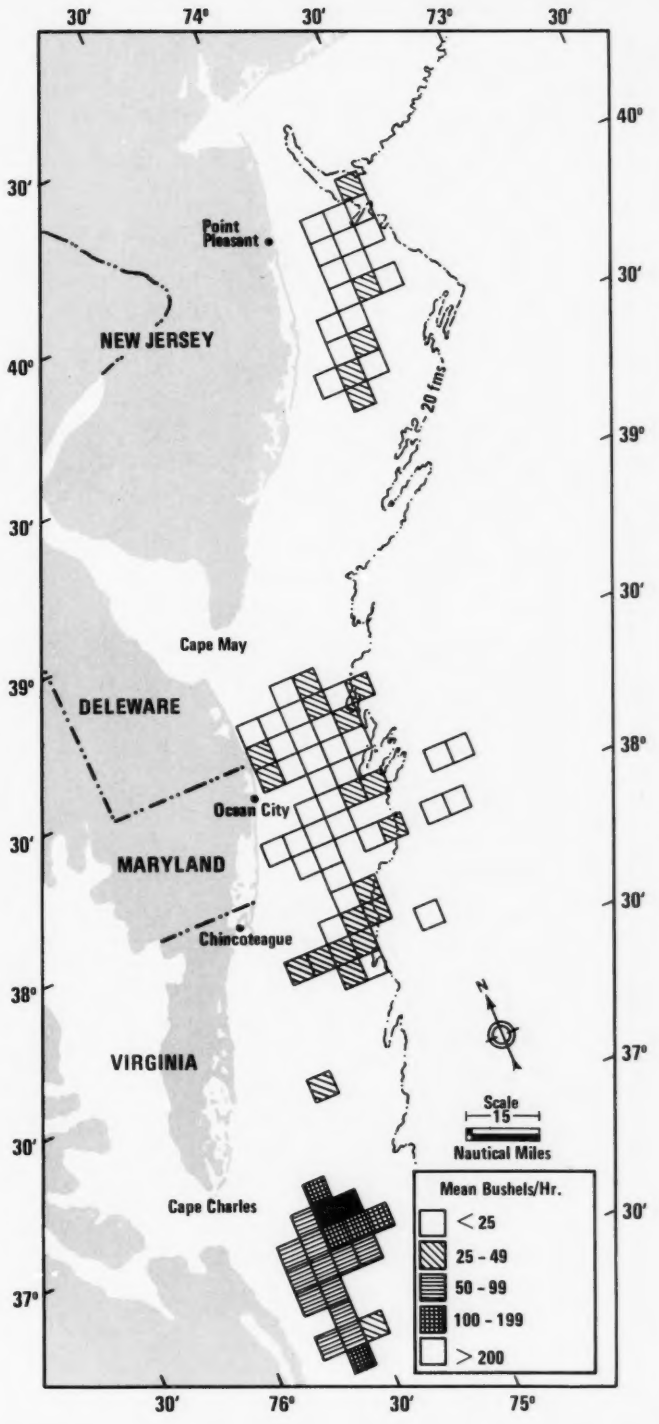


Figure 3.—Catch per hour within the area fished by the Point Pleasant, N.J., Maryland, and Virginia fleet in 1974 (based on 520 interviews).

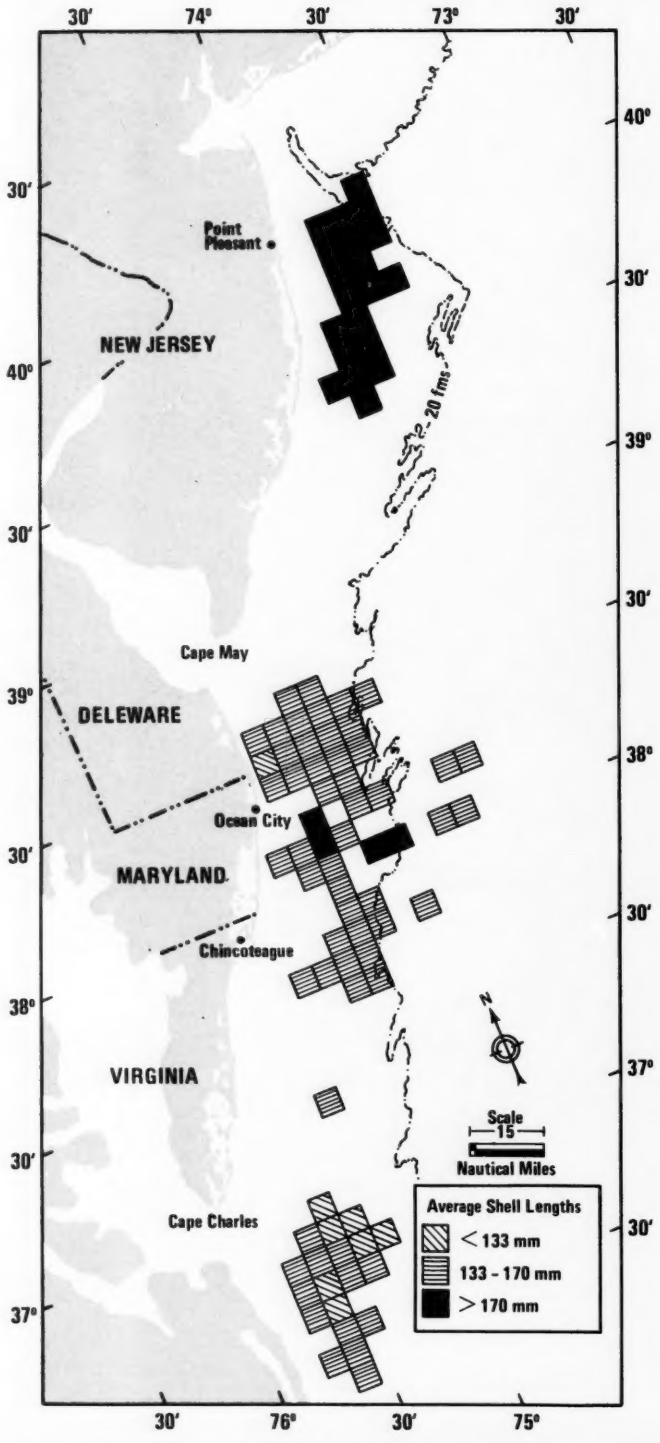


Figure 4.—Mean shell length of surf clams and area of catch by the Point Pleasant, N.J., Maryland, and Virginia fleet in 1974 (based on 520 interviews).

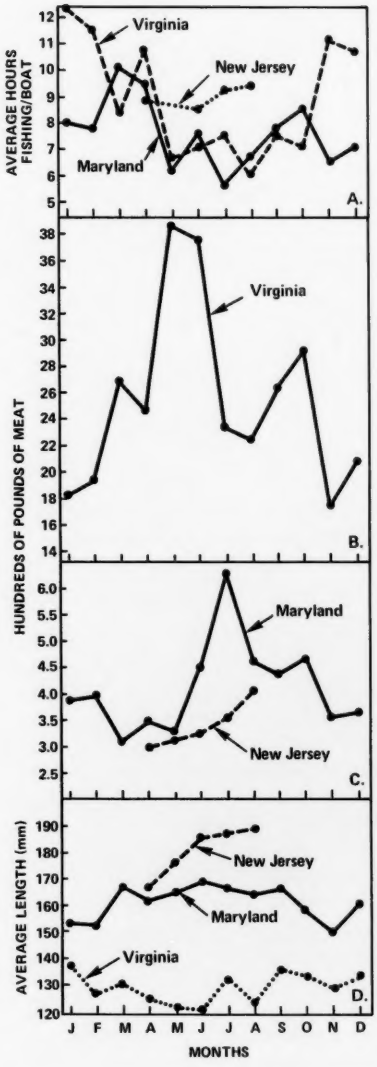


Figure 5.—Monthly averages of trip effort (A), catch per hour (B and C), and shell lengths of surf clams (D) at Point Pleasant, N.J., Maryland, and Virginia ports—1974 (based on 520 interviews).

hour increased by 41 bushels (697 pounds) from 120 bushels (2,040 pounds) in 1973. The fleet concentrated in a relatively small area, most of which had been reported as the Virginia fishing area in 1972 and 1973. Stern dredge vessels, which can harvest greater quantities of clams than other vessels (Ropes, 1972), increased from 6 to 13 at the Virginia ports between 1972 and 1974. Based on the average per vessel catch of 3 million pounds per year (Ropes, 1972), the stern dredge vessels may have accounted for 67 percent (39 million pounds) of the 1974 Virginia landings.

A smaller Maryland fleet (4 less) landed 2.1 million pounds fewer meats in 1974 than 1973. In 1974, operations expanded to include 500 more square miles of ocean; averaged 0.3 more hours fishing time; 9 more bushels of clams per trip; and caught clams that averaged only 1 mm (.04 inch) smaller. This slight increase in effort was not sufficient to compensate for the fewer vessels.

A smaller fleet (2 less) at Point Pleasant, N.J., landed 0.6 million pounds fewer meats in 1974 than 1973. In comparing interview statistics for 1974 with 1972 (none were available for 1973), an equal amount of fishing area was occupied, but the grounds extended more north and south and nearshore areas were avoided in 1974. The fleet averaged 0.2 hour less fishing time and caught an average of 21 more bushels of clams with a mean length 28 mm (1.1 inches) larger than in 1972. The mean of 158 mm (6.2 inches) reported for 1972 was the highest record at that time. The much larger 1974 size may be due to sampling bias, although the fleet concentrated on offshore beds of large clams, as is indicated by a higher average number of bushels per shorter day trip than in 1972.

**Table 2.—Landings by state and distance from shore (data from W. E. Brey, Division of Statistics and Market News, National Marine Fisheries Service, NOAA).**

| State | Landings (millions of lb) by distance from shore | |
|---|---|---|
| | 0+ to 3 miles | 3 miles and over |
| New York | [1]3.8 | 0 |
| New Jersey | [1]12.1 | 10.4 |
| Delaware | 0 | 5.8 |
| Maryland | 0 | 5.4 |
| Virginia | 5.5 | 52.7 |
| Total | 21.4 | 74.3 |

[1]Less bait.

In 1974, landings from beds 0+ to 3 miles of 21.4 million pounds were 22.4 percent of the annual total: New Jersey vessels took 56.5 percent of the total catch from inshore beds; Virginia vessels took 25.7 percent; and New York vessels took 17.8 percent (Table 2). All New York landings were from inshore beds. Inshore beds off New Jersey contributed 12.1 million pounds (53.8 percent) to that state's landings: 74.8 percent of these were from off Cape May-Wildwood; 24.7 percent off Atlantic City; and 0.5 percent off Point Pleasant. None of the landings in Delaware and Maryland were from inshore stocks. Although Virginia vessels landed slightly more than a quarter of the total inshore catch, the 5.5 million pounds was only 9.5 percent of that state's total (52.8 million pounds). High catch rates on inshore beds are expected to result in landings from these stocks as high or higher in subsequent years.

## ACKNOWLEDGMENTS

We are grateful to David McQuay and David Townsend for compiling data and making the initial preparation of graphs and figures.

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MFR PAPER 1250

# The Right Package for Frozen Fish

L. J. RONSIVALLI

As in other meat animals, a variety of spoilage mechanisms are activated in fish soon after they die. These cause the eating quality of the fish to deteriorate by different pathways depending on whether they are frozen or not frozen. This article is concerned only with frozen fish and will not consider any aspect of handling of fresh fish.

When fish of high quality are held in a freezer, their quality is reduced and this quality loss becomes evident by a toughening of the texture, by oxidation of the fat (even in lean fish), and by loss of water. Loss of water is undesirable not only because it has a bad effect on the quality, but also because it reduces the weight of the product, sometimes substantially. Fish will last for months when they are stored in a freezer and it has been amply demonstrated that the colder the storage temperature, the longer they will last. Considering the value of fish, control of the storage temperature remains an economic advantage—a fact which is now receiving wider recognition than it has in the past. An equally important but less appreciated fact is that proper packaging of fish also provides a substantial economic advantage to fish processors.

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Packages are selected for a variety of reasons—they are protective, attractive, etc. However, we now know that the packages selected for frozen fish must prevent the entry of air and the escape of water. Fish packaged in gas-impermeable containers last longer than those packaged in films that allow gases to pass through. Therefore, it can be seen that with the proper package, fish quality can be maintained longer, and rancidity and dehydration can be prevented. Too often there is the misconception that packaging is packaging and that any plastic package will do.

While any package is satisfactory for some products, it is certainly not the case for fish products. For example, "poly" bags (made from polyethylene) are very popular and are satisfactorily used for many products, but they are definitely not at all satisfactory for packaging fish. Polyethylene allows air to come into the packaged fish so easily that it might just as well not be used. The oxidative reactions continue unabated. Thus, the fish spoils just as easily as if it were not packaged.

"Poly" bags do prevent dehydration, however, so from that standpoint they are actually better than nothing at all. It cannot be emphasized too strongly, therefore, that fish will last longer when they are properly packaged. Gas-impermeable packages can be made from a number of materials which include coated cellophanes, polyester, polyvinylidene chloride, nylon-11, aluminum laminates, certain rubber hydrochlorides, and polyvinyl alcohol. Some of these are coated to improve certain functional properties such as sealability. These are more expensive than plain "poly" bags, but considering the value of fish and the vulnerability of its quality, they are definitely worth the extra cost from the points of view of both the industry, which gains an economic advantage, and the consumer, who gains through improved quality. One need only to study the results of surveys by Consumers Union[1] and other consumer groups on the quality of frozen fish to understand the economic advantages bound to accrue when the quality of fish is not permitted to become unacceptable—a situation that results in considerable product loss and in dissatisfied consumers.

In summary, frozen fish should be packaged only in gas-impermeable containers and they should be stored at low temperatures (never above 0°F).

[1]Mention of commercial or trade names or products in this article does not imply endorsement by the National Marine Fisheries Service, NOAA.

*MFR Paper 1250. From* Marine Fisheries Review, *Vol. 39, No. 5, May 1977. Copies of this paper, in limited numbers, are available from D825, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*

# THE 200-MILE LIMIT LAW TAKES EFFECT

The National Oceanic and Atmospheric Administration, on 1 March, put into effect an historic new law that for the first time gave the United States the opportunity to manage fishing off its coasts and to restore its fishery resources, Secretary of Commerce Juanita M. Kreps has announced.

NOAA's National Marine Fisheries Service is administering the Fishery Conservation and Management Act, which gives the United States authority to conserve and manage marine fisheries, except tuna, 200 miles out from our shores. This encompasses more than 10 percent of the world's marine fish.

"An immediate effect of the law will be a reduction in the amount of fish to be harvested by foreign fishermen within 200 miles of our coasts," said Secretary Kreps. In 1974, the last year for which there are complete records, the foreign harvest was 3.3 million metric tons; this year it should be reduced to two-thirds of that level.

No foreign fishing is permitted for several important species groups previously caught by foreign vessels, but now reserved exclusively for U.S. fishermen. These include, on the east coast, cod, haddock, and yellowtail flounder. (Lobsters have traditionally been barred from foreign fishing.) In the Pacific, king crab and shrimp are reserved for U.S. fishermen. In addition, foreign vessels are not to be permitted to fish for certain other species or stocks but will be permitted to keep incidental catch.

"The new law, by far the most significant marine fishery legislation in our history, represents an unparalleled opportunity to revitalize a resource of major importance to our country and the rest of the world," Secretary Kreps said.

The Act, signed into law 13 April 1976, not only represents a major conservation achievement, but brings to government a totally fresh approach to natural resource management by the United States, she added. Under the Act, fishery management plans are developed by eight Regional Fishery Management Councils. They include representatives of the Federal Government, State fishery administrators, and groups of private citizens. They have 108 voting members, 63 of them appointed by the Secretary of Commerce from nominations submitted by State Governors.

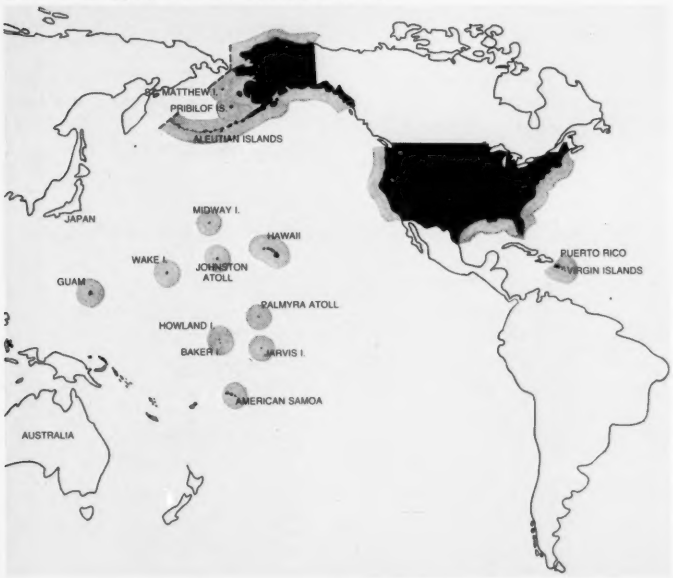
The Councils came into being in August 1976, and since then have held nearly 60 meetings, named chairmen and executive directors, selected headquarters locations, and begun work on their management plans. Public comment and participation is sought for all Council activities.

Since it was not possible for these newly formed Councils to develop detailed plans for each fishery in time for the 1 March deadline, NOAA's National Marine Fisheries Service developed preliminary management plans to govern foreign fishing. Sixteen preliminary plans, covering nearly 30 species of fish, have been developed. They remain in effect until the Regional Councils have developed permanent plans, which will then supersede the present regulations and will control both foreign and domestic fishing. Eventually, management plans are expected to be in operation for some 75 fisheries. Each plan, made on the basis of sound conservation practices, specifies the surplus—if any—which foreigners will be permitted to take, beyond the catch of U.S. commercial and recreational fishermen.

"The 10 months since the passage of the Act have required a tremendous effort in planning and organization," Secretary Kreps said. "Complex negotiations with many other nations have been carried out by the Department of State. Plans have been made by the Department of Transportation (U.S. Coast Guard) and the National Marine Fisheries Service for enforcing the new regulations.

"Setting up the machinery for this extensive and entirely new kind of resource management has been an unprecedented challenge, which is now being met," she said. In order for foreign vessels to fish off U.S. coasts by 1 March, a complex series of steps was required by the new law. As a first step, Governing International Fisheries Agreements (GIFA) had to be negotiated by the Department of State and signed by each foreign nation desiring to fish inside the 200-mile zone.

The U.S. 200-mile fishery conservation zone. This map is not an official map of the U.S. Fishery Conservation Zone (FCZ). The latest official description of the FCZ is printed in the Federal Register of 7 March 1977 (42 FR 12937).



The Department of State has informed Commerce that GIFA's have been signed with Japan, the USSR, Bulgaria, Spain, Poland, East Germany, Korea, Romania, the Republic of China (Taiwan), and the European Economic Community (France, Italy, West Germany, Denmark, the Netherlands, Luxembourg, Belgium, Ireland, and the United Kingdom). The U.S. Congress as of 23 February approved six of the agreements, with Bulgaria, Romania, the Republic of China, the German Democratic Republic, the USSR, and Poland.

Following signing of the GIFA's, applications are filed and permits issued based on allocations of the foreign surplus made by the State Department. Allocations of surplus fish to foreign nations began retroactively to 1 January and cover the calendar year. Fish caught during January and February are subtracted from the total allocation. The following 1977 allocations (in metric tons) have been set: Japan, 1,190,960; USSR, 648,700; Poland, 64,460; East German Republic, 20,225; Korea, 78,700; Spain, 14,400; Bulgaria, 8,070; Taiwan, 5,200; Federal Republic of Germany, 6,525; Italy, 4,220; Romania, 1,400; and France, 1,200.

All applications for permits to fish for the allocations must be reviewed by the appropriate Regional Councils. By late February, Secretary Kreps said, foreign nations had submitted applications for 1,041 ships—both fishing and support vessels—to operate within the 200-mile zone. They are: from the USSR, 468; Japan, 376; Korea, 73; Taiwan, 45; Poland, 33; East German Republic, 27; Romania, 13; Bulgaria, 6.

No permits had been issued to foreign nations by late February and NMFS was in the process of approving foreign applications. Permits were to be issued when a foreign nation accepted the conditions and restrictions imposed on it and promised to pay applicable fees before 1 May 1977. U.S. observers were to be stationed on some foreign vessels.

Secretary Kreps said it would not have been possible to complete this intricate process without continuing cooperation by the Congress. The Senate and House of Representatives acted speedily to extend critical deadlines by passing a Joint Resolution that was signed into law by President Carter on 21 February.

## West Coast Trawl, Sablefish Fisheries Preliminary Management Plans Approved

Preliminary Management Plans regulating foreign fishermen in two fisheries have been approved by Secretary of Commerce Juanita M. Kreps. These plans, for the trawl fishery off the coasts of Washington, Oregon, and California and the sablefish fishery in the Gulf of Alaska, Bering Sea, the Aleutian Region, and off the coasts of Washington, Oregon, and California, are required by the Fishery Conservation and Management Act of 1976.

The Preliminary Management Plan for the trawl fishery off the Washington, Oregon and California coasts establishes control over foreign fishing for Pacific hake, Pacific ocean perch, rockfishes, Dover sole, flounders, jack mackerel, Pacific cod, lingcod, grenadiers, sharks, skates, sablefish, and sculpins. Although foreign fishermen have taken all of these species in the past, they now will be allowed to take only Pacific hake and jack mackerel. Furthermore, foreign vessels will be permitted to retain only an insignificant amount of other species that are taken incidentally when fishing for hake.

In 1974, the foreign catch for all species in this fishery was estimated to be 238,000 metric tons (t). The U.S. catch was about 54,000 t, for a total harvest of 292,000 t. The total allowable catch for 1977 has been reduced to about 266,000 t, of which foreign vessels may take 123,200 t of Pacific hake and 4,000 t of jack mackerel.

Major aspects of the regulations implementing the plan are: 1) Fishing for Pacific hake and jack mackerel will be permitted only in areas over the Continental Shelf where fishing is authorized; 2) foreign fishermen can use only trawls that do not reach the bottom; 3) foreigners will not be permitted to keep any salmon, Pacific halibut, or creatures of the Continental Shelf such as crabs unless authorized; 4) minimum mesh size for trawls landward of longitude 125°40′W will be 4.33 inches, stretched measure, and no liners will be permitted in the cod end of the trawls; 5) no foreign fishing will be permitted within 12 miles of the U.S. coast; and 6) foreign fishing is prohibited in the following areas:

a) Latitude 47°30′N north to the U.S.–Canadian border;
b) U.S.–Mexican border north to latitude 39°N;
c) Columbia River Pot Recreational Fishery Sanctuary;
d) Klamath River Pot Sanctuary; and

## New England Fisheries Plans Okayed

Secretary of Commerce Juanita M. Kreps announced approval of preliminary fishery management plans for New England fisheries on 9 February. She said the plans, which regulate only foreign fishing, "deal in a spirit of fairness both with U.S. and foreign interests."

"In the case of the lobster fishery, which is prohibited to foreign fishermen, the plans provide opportunity for Americans to protect their gear in closed areas, while still offering access to adjacent fishing grounds for foreign vessels," she noted. The management plans, to be carried out by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service, became effective on 1 March. The plans will close certain Northwest Atlantic areas from foreign trawler fishing from time to time to avoid infringement upon the fixed lobster gear of the American fishermen.

A specific area, closed to foreign trawl fishing while domestic lobstermen's pots are in place, is located along a narrow strip between 100 and 200 fathoms, roughly from Georges Bank to Cape Hatteras, following the contour of the Continental Shelf. However, while foreign fishermen are allowed to fish within other specified areas, or "windows" in the 200-mile fisheries conservation zone, they will not be allowed to engage in trawl fishing in any place where U.S. lobstermen have planted their lobster pots and have reported those locations to the U.S. Coast Guard.

e) Latitude 39°N to latitude 47°30′N landward to longitude 125°40′W prior to 1 June 1977, and after 31 October 1977.

Major aspects of the regulations implementing the other Plan regulating foreign fishing for sablefish are as follows: 1) Foreign fishermen will not be permitted to keep any salmon, Pacific halibut (except Canadian fishermen), or creatures of the Continental Shelf such as crabs unless authorized; 2) no foreign fishing within 12 miles of the U.S. coast except for certain areas in the western Aleutian Islands; and 3) foreign fishing is permitted in the following areas at the times indicated:

a) Bering Sea or the Aleutian Islands,
   —Between longitude 169° and 170°W, dragnet fishing from May 16 through November 30 and longline fishing year-round.
   —Between longitude 170° and 172°W, dragnet and longline fishing year-round,
   —Between longitude 172° and 176°W, longline fishing from April 1 through October 31 and
   —West of longitude 176°W, dragnet fishing from May 1 through December 31 and longline fishing year-round.
b) Waters off the Pacific coast of the Aleutian Islands,
   —Between longitude 169° and 172°W, dragnet and longline fishing year-round,
   —Between longitude 172° and 178°30′W, longline fishing from 1 April through 31 October, and
   —West of longitude 178°30′W, dragnet fishing from 1 May through 31 December and longline fishing year-round.
c) Gulf of Alaska (east of longitude 170°W and north of latitude 54°30′N),
   —Catch limited to 4,000 t by trawl gear and 15,500 t by longline/trap gear,
   —Foreign fishing must be conducted seaward of the 500 m depth contour, and
   —No foreign fishing in the International North Pacific Fishery Commission southeastern statistical zone.

The plan declares a sablefish surplus of 5,000 t in the Bering Sea, 2,400 t in the Aleutian area, and 19,500 t in the Gulf of Alaska. There is no surplus off the Washington, Oregon, and California coasts. U.S. fishermen are expected to harvest 2,500 t in the Gulf of Alaska and 7,000 t off the U.S. west coast.

For both of the preliminary management plans foreign fleet commanders must report when they enter and leave the authorized fishing areas and make monthly catch and effort reports, and all foreign vessels must accept a U.S. observer, if requested, and pay all expenses of the observer. These preliminary plans, effective 1 March, remain in effect until Fishery Management Plans are developed by the geographically responsible Regional Fishery Management Council.

## New England Cod, Haddock, and Flounder Quotas Set

United States fishermen in New England will be permitted to catch more cod and haddock in 1977 than they did last year, but fewer yellowtail flounder, under regulations developed by the New England Fishery Management Council and approved by Secretary of Commerce Juanita M. Kreps. Foreign fishermen will not be permitted to catch any of the three species. Last year foreign fishermen caught greater amounts of haddock, but less cod and yellowtail flounder, than did U.S. fishermen in the New England fishery conservation zone.

The new regulations were instituted 14 March under emergency provisions of the Fishery Conservation and Management Act, and were effective for 45 days. Secretary Kreps may, if conditions warrant, extend the regulations for a second 45-day period. The quotas apply to both commercial and recreational fishing; the remainder of the regulations apply only to commercial fishermen.

Haddock, cod, and yellowtail flounder are highly desirable species to the domestic fishing industry. They are subject to intense fishing pressure that, in the absence of effective regulations, can lead to overfishing.

Under the regulations, the permissible haddock catch in 1977 is 6,200 tons, compared to 6,684 tons actually taken last year, of which 5,169 tons were caught by U.S. fishermen. The quota for cod is set at 37,300 tons, compared to a catch of 34,023 tons last year; while the yellowtail flounder quota is 14,000 tons, 10,000 tons of which must be taken east of 69 degrees west longitude. The 1976 catch of yellowtail flounder was 19,626 tons, almost all taken by U.S. fishermen.

**Comparative catch figures in tons, New England Fisheries.**

| | 1976 Actual | 1977 Quota | |
|---|---|---|---|
| Haddock | | | |
| Foreign | 1,515 | 0 | |
| U.S. | 5,169 | 6,200 | |
| | 6,684 | 6,200 | |
| Cod | | | |
| Foreign | 9,103 | 0 | |
| U.S. | 24,920 | 5,000 | Commercial, Gulf of Maine |
| | | 2,300 | Recreational, Gulf of Maine |
| | | 20,000 | Commercial, other |
| | | 10,000 | Recreational, other |
| | 34,023 | 37,300 | |
| Yellowtail Flounder | | | |
| Foreign | 97 | 0 | |
| U.S. | 19,529 | 10,000 | East of 69°W |
| | | 4,000 | West of 69°W |
| | 19,626 | 14,000 | |

In 1977 there may be no directed fishery for haddock or for yellowtail flounder west of 69°W longitude. The quotas established are for by-catch only.

The regulations were issued under emergency procedures because an emergency exists in the cod, haddock, and yellowtail flounder fisheries of the Northwest Atlantic Ocean. During January 1977, the U.S. fleet increased landings of haddock, a severely depressed stock, by 41 percent over the same period in 1976. Moreover, as of 1 March 1977, the Northwest Atlantic Fisheries Act of 1950 that previously provided the authority for domestic regulation of these fisheries was repealed.

Both yellowtail flounder and haddock stocks have been seriously over-fished in recent years, and conservation measures applying to both species include trip limitations and landing restrictions. These are designed to prevent further depletion of these valuable fisheries.

In addition, the Director of the National Marine Fisheries Service may close the season for any of the three species. The closure will be determined by monitoring catch records to determine the cumulative and estimated prospective catch, making allowance for incidental catch for the remainder of the year.

## Regional Fishery Management Councils Form Committees

Three of the Nation's eight Regional Fishery Management Councils established scientific and statistical committees authorized by the Fishery Conservation and Management Act of 1976 (FCMA), according to the National Oceanic and Atmospheric Administration. Administered by the Department of Commerce, through NOAA's National Marine Fisheries Service, this new law gives American fishermen first choice at fishery resources under its jurisdiction. Excess stock that is not harvested domestically may be provided for foreign fishermen through the councils organized to control the fisheries off all U.S. shores.

A scientific and statistical committee assists in the development, collection, and evaluation of statistical, biological, economic, social, and other scientific information pertaining to the development and amendment of any fishery management plan.

Scientific and statistical committees (SSC) have been chartered in accordance with the Federal Advisory Committee Act by the Pacific, North Pacific, and Western Pacific Fishery Management Councils. Additional committees are being established by the Gulf of Mexico and Caribbean Councils.

As required by the FCMA, each council will ultimately have a SSC. The size and number of subcommittees of the SSC's depend on the number of fisheries to be managed and the complexity of the fishery problems. Approximately 75 "management units" (fishery management plans) will be identified for fishery plan preparation. Plans for some species might be prepared in 6 months; others for which extensive research and data collection are necessary may require two to three years. Periodically, the council's SSC's will hold public meetings to provide an opportunity for the public to participate in the decision-making process.

### *Regional Fishery Management Councils Funded*

Nearly one million dollars had been granted to six of the nation's eight Regional Fishery Management Councils for administration and management plan development by late February, according to the National Oceanic and Atmospheric Administration (NOAA). The North Pacific, Mid-Atlantic, and New England Regional Fishery Management Councils were allotted $182,800, $178,800, and $171,300, respectively, the second series of such grants under the Fishery Conservation and Management Act of 1976.

Commonly referred to as the "200-mile limit," the landmark legislation established Regional Fishery Management Councils, and gives American fishermen preference over foreign fishermen who want to use U.S. fishery resources. Previously, the Pacific, Western Pacific, and South Atlantic Councils were allotted $141,200, $160,400, and $141,500, respectively, bringing the total to $976,000. Grants for the Gulf of Mexico and Caribbean Councils were expected soon.

Secretary of Commerce responsibilities have been delegated to NOAA's National Marine Fisheries Service which will fund Council operations through annual grants. The first grants covered October 1976 through March 1977; the second, April through September 1977.

Every Council is required to prepare and submit to the Secretary a fishery management plan on each fishery in its geographical area, prepare comments on any application for foreign fishing, conduct public hearings, and make periodic reports. The extension of U.S. fisheries jurisdiction to 200 nautical miles adds an estimated 2.2 million square miles to current fisheries jurisdiction, the management of which is critically important to the future of America's fishing industry.

## Rules, Catch Limits Set for Foreign Fishing

Regulations controlling foreign fishing within 200 miles of the U.S. coasts and enumerating the quantities of various species foreign fishermen can catch have been published by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service.

Effective 1 March, the regulations required every foreign fishing vessel to have an annual permit to fish in waters within the 200-mile Conservation and Management Zone, and to keep U.S. authorities advised of activities within the zone. In the event any of the regulations are ignored, the permit can be revoked or suspended, or other restrictions can be imposed on the violators.

The regulations issued by the Commerce Department agency require each foreign vessel to submit to inspections when requested by the Coast Guard or NMFS agents, and agree to have NMFS observers aboard if requested. Foreign vessels are required to display identification numbers visible to monitoring ships or aircraft, and also

## FISHING FEES SET FOR FOREIGN SHIPS

A schedule of fees to be charged foreign vessels and foreign nations to fish within 200 nautical miles of the U.S. coasts has been announced by the National Oceanic and Atmospheric Administration, a Commerce Department agency. The fees are authorized by the Fishery Conservation and Management Act of 1976.

Fees to be charged each foreign nation permitted to fish within the conservation zone from 1 March through 31 December 1977, are permit fees, poundage fees, and observer fees.

The permit fee is a fixed annual fee of $1 per gross registered ton for each vessel engaged in fishing; a fixed annual fee of 50 cents per gross registered ton for any vessel engaged in processing fish, not to exceed $2,500 per vessel; and, a fixed annual fee of $200 for vessels assisting other ships in harvesting or processing.

The poundage fee, for 1977, is a fee of 3.5 percent of the dockside price of fish that are allocated to each foreign nation. The value of the fish will be determined by the dockside price received by U.S. fishermen in 1975 as published in "Fisheries of the United States." For species not landed in the United States, appropriate foreign dockside prices will be used.

For observer fees, foreign nations will be required to reimburse the United States on an annual basis for all costs of placing observers on board the foreign vessels, including salary, per diem, transportation, and overhead.

NOAA's National Marine Fisheries Service expected about 1,100 foreign fishing vessels to apply for fishing privileges off the United States.

Revenues from the fees in 1977 are expected to amount to $1.4 million from the permit fees, $10.4 million from the dockside value of the fish taken, and $750,000 from observer fees, for a total of $12.5 million, assuming that the projected number of foreign vessels will be permitted to fish and the projected allocations are made.

The Fishery Conservation and Management Act of 1976 requires that fees charged to foreign nations and vessels be reasonable and apply nondiscriminatorily to each foreign nation. The fees may take into account the cost of administering the Act with respect to foreign fishing and may include, but not be limited to, the cost of fishery conservation and management, fishery research, administration, and enforcement.

As of 1 March the Act prohibited foreign fishing without payment of the requisite fee. The fee schedule was published in the Federal Register on 9 February 1977.

must maintain logs of "catch and effort" information.

Under the Fishery Conservation and Management Act of 1976, U.S. fishing vessels are given the first opportunity to harvest a species of fish. That portion of the optimum yield which it is expected will not be caught by U.S. fishermen is declared surplus, and foreign vessels may apply to fish for it.

The surpluses for foreign fishing in the Atlantic Ocean for 1977 by species are: silver hake, 85,500 metric tons (t); Atlantic herring, 22,000 t; Atlantic mackerel, 69,000 t; short-finned squid, 23,500 t; long-finned squid, 19,000 t; red hake, 34,900 t; butterfish, 5,500 t; river herring, 500 t; and all other finfish, 60,000 t.

The surpluses in the Pacific Ocean are: rockfish, 54,500 t; sablefish, 26,900 t; flounders (except halibut), 231,500 t; Pacific cod, 60,300 t; Alaska pollock, 1,099,000 t; Atka mackerel, 22,000 t; Pacific hake, 123,200 t; jack mackerel, 4,000 t; squid, 10,000 t; other groundfish, 109,800 t; herring, 20,000 t; snails (meat), 3,000 t; tanner crab, 12,500 t; and seamount groundfish, 2,000 t.

The regulations will continue in effect until either amended by NMFS or superseded by regulations implementing fishery management plans developed by the nation's eight Regional Fishery Management Councils. The regulations were published in the Federal Register on 11 February.

## *Growth, Mortality Rates of Ocean Quahog Sought*

Word of the existence of 100-year-old ocean quahogs, also known as mahogany clams, comes from Princeton University. There, Ida Thompson, assistant professor in the Department of Geological and Geophysical Sciences, is studying the growth rates and natural mortality of ocean quahogs and surf clams, both commercially important species on the east coast of the United States.

Supported by a Sea Grant from the National Oceanic and Atmospheric Administration (NOAA), a Commerce Department agency, Thompson is trying to establish a relationship between the growth rings found on the quahog's "hinge plate" and its age.

"The ocean quahog has a little tooth, called a hinge plate, where its upper shell is hinged to its lower shell," Thompson explained. "By cutting a vertical section of this tooth and then polishing it, we can see distinct growth rings under magnification, just like the rings on a tree."

Thompson theorizes that these rings are caused by checks in the clam's growth, probably due to cooler temperatures or decreased food supplies in the winter months. As such, she said, there should be one ring for each year of the clam's life.

To check her theory, some of the clams are being independently aged, using carbon-14 and radium-228 dating techniques. In addition, Thompson has had about 150 quahogs planted in the sand off Point Pleasant, N.J., in a mark-and-recovery experiment. Some of the shellfish will be harvested this October to determine how much they have grown.

Preliminary results of clam samples indicate that about 25 percent are almost 100 years old. Thompson's chief concern, however, is not just with how long the ocean quahog lives, but with how rapidly it grows and develops. According to preliminary studies, it would appear the quahog grows

very slowly indeed. "The evidence so far," Thompson said, "indicates that after 18 to 20 years the typical animal has reached only about 6 cm in height. That's less than 2½ inches." Such slow growth, according to Thompson, suggests that these shellfish may take much longer to reach sexual maturity than do other clams found on the Atlantic continental shelf.

"Our best guess right now," she said, "is that the ocean quahog doesn't reach sexual maturity until it's about 8 or 10 years old." By contrast, the typical surf clam found in adjacent areas is capable of reproducing at about one year of age and seldom lives to be more than 15 or 20.

Recent events have made information on the age of ocean quahogs of more than academic interest. Massive fish kills off the New Jersey coast last summer apparently were caused by anoxia—the total depletion of dissolved oxygen—in the bottom waters. One result of this environmental catastrophe is just now becoming known: vast numbers of surf clams in the affected areas were killed, perhaps as many as half the existing stocks.

According to Thompson, a problem may arise if the ocean quahog is viewed as a ready substitute for depleted stocks of surf clams. "This is particularly true if our age estimates of the quahog, especially age at maturity, are correct," she said. The ocean quahog may take so long to reach reproductive size, she believes, that any major unmanaged harvesting efforts could quickly reduce the stocks of the shellfish.

Thompson hopes the results of her work will lead to better management of New Jersey's surf clam and ocean quahog resources. "There hasn't been a great exploitation of the ocean quahog off New Jersey yet," she said, "and the more we know about the ocean quahog, the better our chances are of undertaking sound management techniques."

## *Endangered Status Asked for Caribbean Monk Seal*

The Caribbean monk seal has been proposed for listing as an endangered species by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service, under the authority of the Endangered Species Act of 1973. While it is feared the animal may already be extinct, NMFS believes it should be listed as endangered in case remnant members of the species still exist. This would provide survivors protection under the Act upon discovery.

Karl W. Kenyon, a noted marine mammalogist, conducted an extensive aerial survey of the Caribbean monk seal's former habitat in the Gulf of Mexico and Caribbean Sea in 1973, and the assumption that the species is extinct is based upon this survey. However, two other species—the Guadalupe fur seal (*Arctocephalus townsendi*) and Juan Fernandez fur seal (*Arctocephalus philippi*)—were once thought to be extinct but later were found still to be in existence.

The former distribution of the Caribbean monk seal included the shores and islands of the Caribbean Sea and Gulf of Mexico from the Bahamas west (including the Florida Keys and Cuba) to the Yucatan Peninsula, south along the east coast of Central America and through the western Caribbean Sea, and eastward in the northern Caribbean to the northern Lesser Antilles.

With needs similar to those of the Hawaiian monk seal, placed on the endangered species list last year, the Caribbean monk seal seeks shallow lagoons and reefs for feeding areas; sandy beaches for hauling-out grounds; and permanent islets or beaches above high tide, and adjacent to shallows, for pupping areas.

Although Caribbean monk seals seemingly are tame and allow a close approach, they historically have abandoned habitat used by man for fishing or other purposes. Reports indicate that this species was indiscriminately killed for hides and oil since early Spanish exploration of the western hemisphere.

## Puerto Rico University Receives First Sea Grant

A program of marine advisory services will be started in Puerto Rico under a National Sea Grant Program grant awarded early this year by the National Oceanic and Atmospheric Administration (NOAA). The grant of $39,900 to the University of Puerto Rico, marks the first time Sea Grant funds have been awarded in Puerto Rico, according to Ned A. Ostenso, Director of the National Sea Grant Program.

"We are happy to be able to assist the University of Puerto Rico in its efforts to establish an advisory program that will provide assistance to fishermen and others in Puerto Rico," Ostenso said during ceremonies in Washington at which the Commerce Department agency award was presented to Arturo Morales-Carrion, President of the University of Puerto Rico.

Morales-Carrion said this year's Sea Grant program in Puerto Rico "represents only the beginning of what we contemplate in terms of a substantial participation of the University of Puerto Rico in Sea Grant activities.

"The experience the first year," he said, "will serve as a point of departure for future Sea Grant planning and involvement, not only at the University but in Puerto Rico as a whole."

The grant-funded program will provide technical training to marine extension agents who will serve as a nucleus for a corps of marine advisory service specialists. The program will provide fishing skill training for about 250 commercial fishermen on the east and southeast coasts of the island, including the Vieques and Culebra coastal municipalities. Matching funds of $20,132 from non-Federal sources will augment the Sea Grant. The program further is designed to increase public awareness, concern, and appreciation for Puerto Rico's marine and coastal resources, as well as the need for proper conservation measures to preserve those resources.

The Sea Grant activities will be coordinated through a program at Humacao University College, on the east coast of Puerto Rico, in collaboration with the University's Mayaguez campus, which has a marine graduate program.

The east and southeast coasts of the island are characterized, Morales-Carrion explained, by a diversity of marine and coastal environments and ecosystems. In addition to edible fish and shellfish, the area is endowed with innumerable estuaries, rookeries, mangroves, offshore keys, coral reefs, and other living marine systems, he said. The island of Vieques has a spectacular bioluminescent bay, and the coastal waters of Culebra island bear the best coral reefs in Puerto Rico.

Because commercial fishing in Puerto Rico depends largely on bottom fish, Morales-Carrion explained, the conservation of the estuaries, mangroves, coral reefs, and other living marine systems is of great importance to the island's economy.

# NMFS Employees Awarded Commerce Medals

Three National Marine Fisheries Service employees were among 28 individual NOAA recipients of Gold and Silver Medals presented by the Secretary of Commerce at a ceremony in Washington, D.C., late last year.

Dayton L. Alverson, Director of the Northwest and Alaska Fisheries Center, Seattle, Wash., was awarded the Gold Medal, and Edmund S. Hobson and Susumu Kato, research biologists at the NMFS Tiburon Laboratory, Tiburon, Calif., were honored with Silver Medal Awards.

David H. Wallace, Associate Administrator for Marine Resources of NOAA, also was presented a Gold Medal for his outstanding technical leadership in international cooperative fisheries management. He is recognized as the chief architect of a management approach for North Atlantic Fisheries. As the leader of the U.S. delegation to the International Commission for the Northwest Atlantic Fisheries (ICNAF), he helped obtain international agreement on reduced fish catches in North Atlantic, and at the same time increased the catch permitted U.S. fishermen.

Alverson was awarded the Gold Medal for his outstanding performance, abilities, and contributions as an administrator and scientist. Among his notable achievements cited were publication of over 100 articles on fisheries science, and acting as advisor, delegate, or organizer of many important national and international meetings on fisheries.

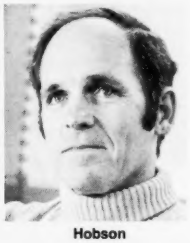
Under Alverson's leadership, the Northwest and Alaska Fisheries Center is recognized throughout the world for its contributions in international fisheries and Law of the Sea activities; fisheries development and conservation; studies on the Columbia River Basin, environmental conservation, resource assessment, and marine mammals; aquaculture research; and publication of quality research results.

Hobson received the Silver Award for pioneering in-depth studies of the ecology of coastal marine fish communities while Kato received his Silver Award for his efforts as the prime mover in the development of new and underutilized fisheries in California.

The highest honor that the Department of Commerce can bestow, the Gold Medal is awarded for: Rare and outstanding contributions of major significance to the Department, the Nation, or the world in science, technology, or administration; highly distinguished authorship; heroic action involving jeopardy of life; and outstanding leadership in the administration of a major program.

Silver Medals are awarded for contributions of unusual value to the Department in science, technology, or administration; outstanding skill or ability in the performance of duties which have resulted in program advancement; meritorious authorship; or unusual courage and competency in an emergency.

Alverson



Hobson

Kato

## Twohig Named Outstanding NMFS Employee for 1975

Daniel J. Twohig, an electronics technician at the Northwest and Alaska Fisheries Center, National Marine Fisheries Service, in Seattle, Wash., was selected last year as the 1975 Outstanding NMFS Employee of the Year. He is the first recipient of this new award which annually recognizes one NMFS employee for significant contributions to agency programs, and exceptional and sustained efforts toward accomplishing NMFS missions.

Twohig's work on a hydroacoustic system development project in the Northwest and Alaska Fisheries Center's Resource Assessment Program served as the basis for his selection. Twohig played a lead role in converting an entire computer system with its associated acoustic and data recording systems into a self-contained, portable, and weatherized container. His contribution provides a safer and more efficient operation at sea for hydroacoustic data collection and processing. Twohig was also cited for the exceptional quantity and quality of his work which is producing a major impact on the Center's success in developing advanced technology for monitoring the condition of U.S. Fishery resources.

## Calibration Center Contract Extended

The Oceanographic Institute of Washington, in Seattle, has been awarded a $134,051 contract extension by the National Oceanic and Atmospheric Administration (NOAA), a component of the U.S. Department of Commerce, to continue the operation and management through this September of the Northwest Regional Calibration Center in Bellevue, Wash.

The Center, which services the northwest and some of the Canadian oceanographic scientific and environmental agencies, also performs calibration work for NOAA's National Ocean Survey and other Federal agencies, universities, and commercial firms.

The Center services all of the National Ocean Survey's instrument calibration, such as its deep-sea reversing thermometers which are attached to water sampling devices and used to compute water temperature at various depths. Other scientific equipment calibrated on national standards by the Center are ocean current meters, and temperature, salinity, and pressure instruments.

The Oceanographic Institute has been managing the Calibration Center since the

facility began operations in 1972. The basic contract runs until 30 September 1982, with annual cost negotiations.

## Pollution-Bearing Matter Studied in Puget Sound

Outflow from rivers helps cleanse Washington State's Puget Sound of pollutants, but tiny particles washed into the Sound by those same rivers may be the vehicles for driving at least one pollutant, oil, deeper into the ecosystem.

Scientists with the National Oceanic and Atmospheric Administration (NOAA) in Seattle are studying the types and distributions of suspended matter—floating particles—in the waters of northern Puget Sound, and testing sediments from rivers to learn whether these particles play a role in enhancing or minimizing the impact of pollutants.

With funds from the Interagency Energy Environment Program, managed by the Environmental Protection Agency, Edward Baker, Joel Cline, and Richard Feely of NOAA's Pacific Marine Environmental Laboratory have begun a year-long program of measuring the amount of suspended matter in the Sound and collecting water samples to be tested for the presence of hydrocarbons, chemical constituents of oil. The study is managed by NOAA's Marine Ecosystems Analysis Program, which, like the Seattle marine laboratory, is part of the Commerce Department Agency's Environmental Research Laboratories.

Much of the oil that will be coming southward from Alaska's north slope will be brought to refineries along Puget Sound. It has been estimated that the capacity of Puget Sound refineries may double by the 1980's and triple by the year 2000. More and more tankers will be traversing the Sound and the San Juan Islands, transporting crude oil to the refineries and petroleum products away again, and causing a corresponding increase in the chances for accidents producing major spills. Of almost as much concern and greater certainty, however, are the chronic, small-scale inputs—minor spills, seepage during transfer operations—that could have a greater impact over the long term than a single large spill.

Evaporation, photooxidation, and other physical processes, explained Jerry Larrance, head of the Seattle team, remove oil from the marine ecosystem. But oil that adheres to some particles enters the food chain and ultimately becomes part of the bottom sediments. Oil-bearing particles may be eaten by marine organisms such as plankton. But the chain doesn't stop there. Remains of dead organisms and fecal material from the upper water sink to the bottom where they form a major source of food for bottom dwellers. Shrimp, clams, oysters, and crabs may thus ingest hydrocarbon-contaminated material. Oil sedimented on the bottom may also be mixed back into the water column as waves or storm surges disturb the floor of the Sound. So the NOAA scientists are trying to learn the concentrations and distributions of suspended matter in the Sound, and what role different types may play in transporting hydrocarbons through the ecosystem.

Suspended material comes from a variety of sources, according to Larrance. In the Sound, much of it is sediment outflow from rivers, particularly British Columbia's Fraser River whose plume flows southward through the San Juan Islands, along the very routes tankers will take. Other suspended materials are biological—organisms like plankton and their remains.

The first expedition in the NOAA project was completed in mid-November. On the MESA chartered vessel, *Snow Goose*, the researchers made measurements at 34 sites in Puget Sound, around the San Juan Islands, and in the eastern Strait of Juan de Fuca. Using a unique instrument designed by scientists at the University of Washington, the NOAA oceanographers measured the light scattering properties, an indirect measure of the amount of particulate matter, of the water at each site. The device, a nephelometer, provided a continuous vertical profile of light scattering at different depths as it was lowered into the water. At some of the sites, the researchers collected water samples to see how actual concentrations of suspended matter compared with the nephelometer readings, and measured standard physical characteristics such as salinity and temperature of the water.

At five sites, the team anchored for 16- to 24-hour experiments in which nephelometer measurements were made every hour, and water samples collected every four hours. The water samples will be analyzed for type of suspended matter.

The researchers also are collecting samples of the suspended material itself for analysis. A submersible pump is lowered over the side of the vessel, and a centrifuge on deck extracts the suspended matter. With a gas chromatograph on shipboard, the samples can be analyzed immediately for the lighter weight hydrocarbons, such as butane, methane, and propane. Later, the NOAA National Analytical Facility in Seattle, part of the National Marine Fisheries Service, will analyze these samples for heavy hydrocarbons, a process requiring more complicated equipment than can be carried on the *Snow Goose*. Two more such transits of the study area are planned later this year.

Meanwhile, samples of Prudhoe Bay crude oil will be tested in the laboratory with suspended material from the Fraser and Skagit Rivers under a variety of simulated natural conditions. Hydrocarbons will also be tested with filtered "clean" sea water from the Strait. This is not an isolated study, Larrance explained, but part of a continuing effort to look at the ability of suspended matter to hold hydrocarbons, especially petroleum hydrocarbons, and its role as an agent for the transport of hydrocarbons through the ecosystem. In the future, he added, the group will be studying other locations, other pollutants. "Our interest is the transport of pollutants in general."

## SKIPJACK TUNA TAG MYSTERY SOLVED

Identification of a mysterious tag found on a skipjack tuna near Hawaii last December, announced by Richard S. Shomura, Director, Honolulu Laboratory, Southwest Fisheries Center, National Marine Fisheries Service, NOAA, has added another bit of knowledge about the long-range west-to-east movement of the species in the Pacific Ocean.

The particular skipjack tuna was captured on 9 December 1976 about 45 miles south of the Waianae coast by a local aku sampan, the *Bluefin*, and bore a plastic tag used by fishery scientists to trace the migration of fish. However, the tag had no legend identifying the research agency that tagged the fish. The inner core of the tag carrying the legend had somehow fallen off and what remained was only the outer tubing.

In an attempt to solve the mystery, the nameless tag was sent to a scientist at the Inter-American Tropical Tuna Commission (IATTC), William Bayliff, whom it was thought may have a clue as to its origin. Scientists at the IATTC have tagged thousands of skipjack tuna in the eastern Pacific. However, the tag was not the type used by IATTC and Bayliff in turn sent it to the Far Seas Fisheries Research Laboratory (FSFRL) in Shimizu, Japan for possible identification. Japanese scientists have also been tagging skipjack tuna in the western Pacific. The FSFRL scientists soon identified the tag as one of their own. The identification was positive because the tag was part of a batch made with a new type of silicone tubing which had been used only on two occasions by FSFRL scientists, on 17 and 18 May 1976.

The FSFRL scientists believe the skipjack tuna in question was tagged on 17 May in the western Pacific at lat. 31°57′N, long. 159°12′E. The fish probably measured between 42 and 59 cm (16.5 and 23.2 inches) and was among 186 skipjack tuna that were tagged that day by Japanese scientists on board the *Fuji-maru*. The fish was then recaptured 206 days after release, by the *Bluefin*, 45 miles south of the Waianae coast. The fish was 68 cm (26.8 inches) long and weighed 7 kg (15.5 pounds) when recaptured. It had traveled a straight-line distance of over 2,200 nautical miles, or about 11 nautical miles per day, from the point of release to the point of recapture.

Recapture of this particular skipjack tuna represents the first record of a long-term, long-range west to east movement of skipjack tuna in the Pacific Ocean, Shomura noted. The fact that a segment of the population of skipjack tuna in the eastern Pacific migrate to Hawaiian waters has been known to scientists at the Honolulu Laboratory for a number of years. A number of skipjack tuna tagged in the eastern Pacific Ocean have been recaptured in the central Pacific in and around the Hawaiian Islands. Shomura noted that this recapture of a skipjack tuna tagged in the western Pacific and recaptured in Hawaii will probably revise some of the thinking of fishery scientists on the population structure of skipjack tuna in the Pacific Ocean.

## NOAA Spacecraft Monitors Gulf of Mexico Currents, Assists Fishermen and Mariners

Pictures from space are helping mariners sailing the eastern Gulf of Mexico conserve fuel and improve transit times last winter by showing them where Gulf currents are flowing through that body of water. Additionally, commercial fishermen in the area have used the information to locate potentially more productive fishing grounds.

The information on the Gulf Loop Current, a circulation of water that moves roughly clockwise through the eastern portion of the Gulf of Mexico, comes from a geostationary satellite operated by the National Oceanic and Atmospheric Administration (NOAA), an element of the Department of Commerce. The satellite, GOES-1, is in an orbit which permits it to remain in about the same spot over the equator at an altitude of about 22,200 miles (35,720 km).

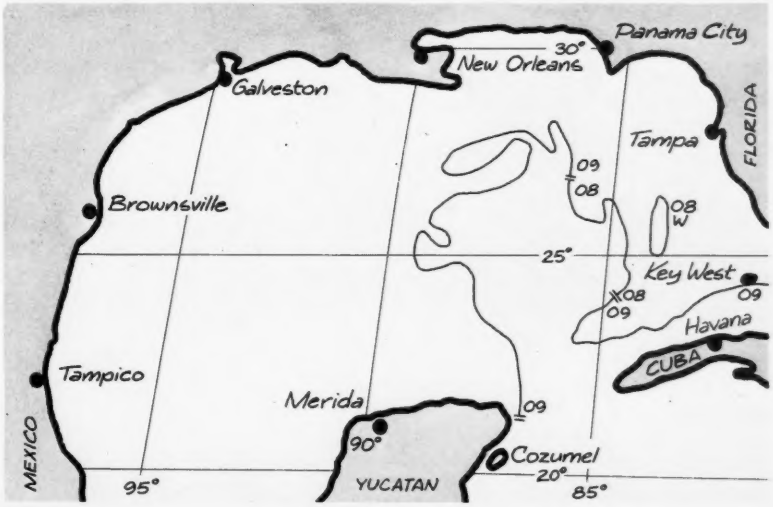
An infrared sensor aboard the spacecraft senses the warmer waters of the current. This information is relayed to NOAA computers near Washington, D.C., and converted into pictures which are in turn transmitted to a NOAA Satellite Field Services Station at Miami, Fla. There, analysts determine and plot the location of the Loop Current's coastward edge by latitude and longitude. The material, now in a form mariners can use, is sent three times a week to National Weather Service Offices along the Gulf Coast.

Donald C. Gaby, Manager of the Satellite Field Services Station maintained by NOAA's National Environmental Satellite Service, said the maximum Loop Currents—which can flow up to a speed of about 3½ knots—are found about 9 miles (15 km) inside the coastward edge of the Loop.

The Loop analysis was provided until May, Gaby said. Then, as Gulf waters warm up to about the same temperature as the waters of the Loop Current, the temperature differential is difficult to see on the infrared imagery. Next November, as the general water temperature declines once more, the analysis will be resumed.

Last winter, in a pilot program, a number of mariners used the Loop Current information in plotting navigation courses, sailing in the current when headed in the direction it was flowing, and avoiding it when headed in the opposite direction. Improved transit times and fuel savings were experienced, Gaby said.

Since certain species of fish sought by




A typical circulation pattern of the Gulf of Mexico Loop Current is seen in this chart, developed by NOAA from satellite pictures of the Gulf. Numerals 08 and 09 refer to the dates (January 8 and 9) on which the features were seen in satellite imagery. The elongated circle northwest of Key West, Fla., identifies a warm eddy that had separated from the current. Since current positions constantly change, NOAA provides an analysis three times a week.

commercial fishermen in the Gulf prefer water temperatures close to those found along the edge of the Loop Current, the location of the current at any given time is of value to the fishermen.

The GOES-1 satellite, launched for NOAA by NASA in October 1975, is one of several operational environmental spacecraft the air and ocean agency operates. In addition to those in geostationary orbit, NOAA also receives environmental data from a spacecraft in polar orbit which monitors all parts of the earth twice every 24 hours.

## Ocean Current Measured Under Bering Sea Ice

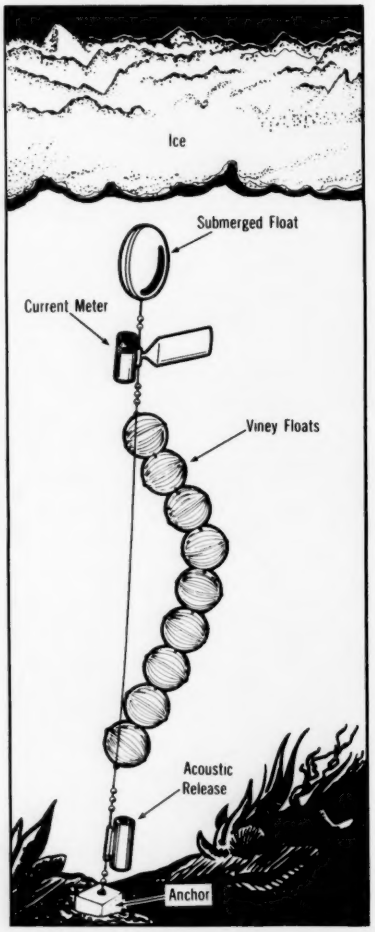
National Oceanic and Atmospheric Administration (NOAA) scientists are taking the first systematic look at how ocean water moves beneath the Bering Sea ice pack. The unique measurements being made by submerged current meters are part of a sub-Arctic study by oceanographers with the Pacific Marine Environmental Laboratory in Seattle, one of NOAA's Environmental Research Laboratories, and with the University of Washington.

What they learn will be applied in a major environmental study managed by the Environmental Research Laboratories for the Interior Department's Bureau of Land Management, in an effort to establish environmental baselines, and to predict the primary marine impact of petroleum development off Alaska.

According to Robert Charnell, the NOAA oceanographer leading the current study, little is known of water movement beneath the northern ice pack—or how water would transport oil spilled into the sub-Arctic marine environment. "We know the water is driven by a large pressure gradient from the Bering Sea northward through the Bering Strait and into the Chukchi Sea, and there's been quite a lot of work on understanding what happens in the summertime. But up there, summer lasts only a month or two. That leaves the largest part of a year for which we have no information as to current speeds and direction, and what the water is doing under the ice. Clearly, if we had an oil spill there in winter we couldn't begin to predict the spill's trajectory."

Charnell points up two aspects of the Bering Strait currents that hold particular interest. One is the focusing—and the corresponding acceleration—of water moving through the Strait itself; another is a split in the current when it clears the Strait, with one stream turning toward Arctic Russia, the other toward Alaska's Beaufort Sea coast. Very little is known about how these properties of Bering Sea water motion change with time and season, or the masses and velocities involved.

The current meters are suspended about 20 feet (seven meters) above the sea floor, in water about 150 feet (50 meters) deep. "We have the meters deep because of the ice," Charnell explained. "The problem is that while you have relatively thin new ice in the pack, some large chunks of old ice get caught. So you have a thin layer over the whole surface, with these big ice blocks extending in some cases almost to the bottom. The Canadians put out nearly 20 current meter stations in the Beaufort Sea a while back and when they tried to recover them they were able to find pieces of only three, they were ground up so badly."




Current meters are suspended about 20 feet above the sea floor in about 150 feet of water.

The present set of current-meter stations was deployed from the NOAA ship *Discoverer* last summer, to form an array of 19 submerged meters. Each mooring consists of a cylindrical meter—about the size of a loaf of bread—attached to a swivelled vane that senses the direction of water motion. The meter is suspended on a cable held taut by a buoyant, streamlined float, and anchored at the bottom by a heavy concrete weight. The cable is connected to the anchor by a coupling that can be acoustically triggered, permitting a string of floats to raise the apparatus to the surface for retrieval.

Four current meters are set west of Cape Prince of Wales, on the American side of the Bering Strait. Seven more are moored in the Chukchi Sea, in a shallow arc westward from Cape Lisburne, almost the northwest corner of Alaska. Two meters are installed at the mouth of Kotzebue Sound, and two more are in a line south of Nome in Norton Sound. Three are set along a southeastward line from St. Lawrence Island in the Bering Sea to the Yukon River delta, with a fourth meter northwest of St. Lawrence Island.

Charnell and his colleagues planned to visit the harsh, ice-dominated environment in which their current meters were wintering. They were to cut holes in the ice near the positions of the submerged meters and take ocean density measurements with portable conductivity–temperature–depth sensors. These soundings below the ice will tell them whether water movement near the current meter is representative of water motion near the surface. The meters will be recovered this summer, and their data record removed for subsequent analysis by the Seattle oceanographers.

# Japan's 1975 Fish Catch Within 200 Miles of Foreign Coasts Shows Continued Decline

Japan's fish catch within 200 miles of foreign coasts in 1975 was 3,744,000 metric tons (t), a 12-percent (512,000-t) drop from the 4,256,000 t caught in the same areas in 1974, according to Japanese Fisheries Agency data (Table 1). About 75 percent, or 2,806,000 t, of the 1975 catch off foreign shores was taken off the U.S. (1,410,000 t) and Russian (1,396,000 t) coasts. Meanwhile, Japan's fish catch within her own 200-mile zone increased from 5,236,000 t in 1974 to 5,503,000 t (5.1 percent) in 1975.

The 1975 catch off foreign coasts represented 35.5 percent of Japan's overall fisheries catch while the corresponding 1974 catch was 39.4 percent of that year's total catch. That is, the dependence of the Japanese fishing industry on catches off foreign nations was about 12 percent less than in 1974. The Japanese Fisheries Agency reportedly attributes the continued fish catch decline off foreign coasts to the drastically reduced pollock quotas in the Bering Sea and off the Soviet Union.

Japanese catches from within 200 miles of the U.S. coast—almost entirely from waters adjacent to U.S. Pacific coast—totaled 1,410,000 t in 1975. This was 13.4 percent of Japan's total 1975 catch and 37.7 percent of Japanese catches within 200 miles of all foreign countries. The 1974 Japanese catch taken within 200 miles of the United States amounted to 1,585,000 t, representing 14.7 percent of Japan's total 1974 catch and 37.2 percent of the Japanese catch from within 200 miles. Thus, while the Japanese catch off the United States decreased in quantity between 1974 and 1975, its relative importance increased slightly, from 37.2 percent to 37.7 percent of all Japanese catches within 200 miles.

In 1975, Japan caught 14,000 t more off the United States than off the Soviet Union. In 1974, the situation was the reverse, as Japan caught 45,000 t more fish off the Soviet Union than off the United States. In 1975, the Japanese fisheries catch off these two countries alone was more than 25 percent of the Japanese total catch.

From 1974 to 1975, Japan's worldwide marine catch, which excludes inland and freshwater fishery catches, declined by 1.8 percent. During the same period, Japanese catches off the United States decreased by 11.0 percent. Although no estimate is yet available for Japan's 1976 marine catch, a preliminary estimate for catches off the United States shows that they decreased by 50,000 t, or by 3.5 percent.

According to the NMFS Office of International Fisheries, Japanese fishermen, mostly from southern Japan, catch about 650,000 t annually in the Yellow and East China Seas. In 1975, Japan caught 152,000 t within 200 miles of the People's Republic of China (PRC) and a reported 150,000 t within 200 miles of the Republic of Korea's (ROK) southern and western coasts. If the PRC and the ROK excluded Japanese fishing vessels from these grounds, Japan would lose 302,000 t (2.9 percent) of its total catch.

Hisao Katagiri, the Director of the International Affairs Division of the Japanese Fisheries Agency, stated that Japan will lose more than it will gain if it extends its fisheries jurisdiction to 200 miles. Soviet fishermen catch from 400,000 to 500,000 t annually within 200 miles of the Japanese coast, while Republic of Korea fishermen catch only about 5,000 t annually in the same 200-mile zone.

Additional information on Japan's fisheries catch in foreign 200-mile zones giving species breakdown for catches off the United States and the USSR is available from the Language Services Branch, (F412), NMFS, NOAA, Commerce Department, Washington, DC 20235.

**Table 1.—Japan's fish catches, in 1,000 metric tons (t), within foreign 200-mile zones, by selected countries in 1974 and 1975.**

| | Catches within foreign 200-mile zones | | | | | | Percent[1] of total fish catch | |
|---|---|---|---|---|---|---|---|---|
| | 1974 | | 1975 | | Loss/gain | | | |
| Country | 1,000 t | % | 1,000 t | % | 1,000 t | % | 1974 | 1975 |
| United States | 1,585 | 37.2 | 1,410 | 37.7 | −175 | −11.0 | 14.7 | 13.4 |
| Soviet Union[2] | 1,630 | 38.3 | 1,396 | 37.3 | −234 | −14.4 | 15.1 | 13.2 |
| North and South Korea | 209 | 4.9 | 241 | 6.4 | +32 | +15.3 | 1.9 | 2.3 |
| China (PRC) | 180 | 4.2 | 152 | 4.1 | −28 | −15.5 | 1.7 | 1.4 |
| New Zealand | 78 | 1.8 | 80 | 2.1 | +2 | +2.6 | 0.7 | 0.8 |
| Canada | 25 | 0.6 | 21 | 0.6 | −4 | −16.0 | 0.2 | 0.2 |
| Australia | 18 | 0.4 | 12 | 0.3 | −6 | −33.3 | 0.2 | 0.1 |
| Others | 530 | 12.5 | 432 | 11.5 | −98 | −18.5 | 4.9 | 4.1 |
| Total | 4,256 | 100.0 | 3,744 | 100.0 | −512 | 12% | 39.4 | 35.5 |

[1]The total Japanese national fish catch in 1974 was 10,808 t; it was 10,545 t in 1975.

[2]If Soviet sovereignty over four disputed islands in the southern Kuriles is accepted as a premise, the Japanese catch off the USSR increased to 1,851,000 t in 1974 and the total 1974 Japanese catch within 200 miles of all foreign nations increased to 4,477,000. Percentages would increase to 17.1 percent and 42.5 percent repectively.

Note: The United States, the Soviet Union, and Canada have extended their fishery jurisdictions to 200 miles; South Korea (ROK), Australia, and New Zealand still maintained 12-mile fishery limits in early 1977.

Source: Japanese Ministry of Agriculture and Forestry, Japanese Fisheries Agency.

## Japan and Russia Begin Large-scale Trade Talks

A large-scale trade involving over $35 million worth of Japanese fishery plant equipment in exchange for supplies of fish from the Soviet Union is being worked out between a Japanese fishery firm Taiyo Fishery and the Soviet Union, according to an announcement in Tokyo on 15 February by the Taiyo's President Tojiro Nakabe, who had recently returned from Moscow after talks with the Soviet Fishery Minister, Alexander A. Ishkov. The Soviets reportedly proposed to purchase, through Taiyo, a refrigeration plant worth about $11 million, tooling equipment for fishing net manufacturing machinery worth about $12 million, and a canning plant worth about $12 million. The Soviets also proposed a barter payment spread over 3 years in supplies of Alaska pollock (25,000 to 26,000 tons), frozen whale meat (600 tons), and pelagic armorhead or other species of fish (3,000 to 5,000 tons). Negotiations on the prices of bartered goods are scheduled to begin in June. Sources: *Suisan Keizai Shinbun* and *Suisan Tsushin*.

# United States Okays Fisheries Agreements With Canada, European Economic Community

The United States and Canada, on 24 February, signed in Washington, D.C. a Reciprocal Fisheries Agreement to permit continuation of fishing by fishermen of each country off the coasts of the other for 1977, following the extension of their respective fisheries jurisdiction to 200 miles. The Agreement was signed on the Canadian side by L. H. Legault, Director General, International Directorate, Department of Fisheries and Environment, and on the United States side by Ambassador Rozanne L. Ridgway, Deputy Assistant Secretary of State for Oceans and Fisheries Affairs. The Agreement enters into force upon completion of internal procedures by both sides.

The Agreement was concluded following discussions between President Carter and Prime Minister Trudeau. The two leaders concurred that a fishery Agreement for 1977 should be concluded on the basis of the same spirit of cooperation which marked their overall discussions. They reviewed the principles which would ensure that the interests of each in the fishery zone of the other are accommodated reciprocally for the remainder of this year.

The two sides looked forward to longer-term arrangements which are yet to be negotiated. They welcomed the signature of the Agreement as an important step in the evolution of their fisheries relationship and as a contribution to their close ties as neighboring states. Source: U.S. Department of State Press Release.

On 15 February, representatives of the United States and the European Economic Community signed a new agreement relating to fishing activities of member states of the Community off the coasts of the United States.

The agreement sets out the arrangements between the parties which will govern fishing by vessels of member states of the Community within the fishery conservation zone of the United States which took effect on 1 March. The agreement was to enter into force after the completion of internal procedures by both parties.

The signing of this agreement took place in Washington, D.C. Lord Bridges, Minister to the United States of the United Kingdom, signed for the Presidency of the Council of the European Communities, and Jean-Pierre Leng signed on behalf of the Commission of the European Communities. Frederick Irving, Assistant Secretary, Bureau of Oceans and International Environmental and Scientific Affairs, signed for the United States. Both delegations expressed their satisfaction with the new accord, and the hope that it will strengthen cooperation between the European Economic Community and the United States: Sources: U.S. Department of State Press Releases.

## *Indonesia Hikes Frozen Shrimp Export Prices*

The Indonesian Government has raised minimum export prices of frozen shrimp for the first quarter of 1977, according to a February report in the *Suisan Shuho*. The new prices are shown below in comparison with those for the last quarter of 1976.

Indonesian minimum export prices (US$/t) for frozen shrimp, January–March 1977.

| Size | New | Old |
|---|---|---|
| *Shell on* | | |
| Under 25 | 6,200 | 6,200 |
| 26–40 | 4,150 | 4,000 |
| 41–50 | 3,675 | 3,500 |
| 51–70 | 2,950 | 2,800 |
| Over 71 | 1,350 | 1,350 |
| *Peeled and deveined* | | |
| Under 40 | 3,100 | 3,100 |
| 41–100 | 1,950 | 1,950 |
| 101–200 | 1,650 | 1,650 |
| Over 201 | 1,350 | 1,350 |

Note: Prices are fob Indonesia.

## Russia's 1976 Coast Salmon Catch 70 Percent Over Plan

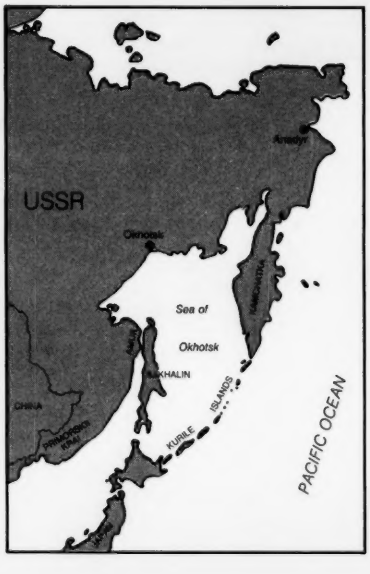
The Soviet Ministry of Fisheries has reported that in 1976 a total of 69,723 metric tons (t) of salmon were caught by Soviet fishermen in the waters off the USSR Pacific coasts. The coastal catch was 70 percent above the year's plan figure of 41,000 t. The Ministry did not report any figures for the high-seas salmon fishery, although the Soviets were permitted to catch up to 5,000 t under the terms of a Japanese-Soviet salmon fisheries agreement. The Japanese Fishery Agency, which receives Soviet catch statistics as part of the agreement, does not believe that the Soviets conducted any high-seas salmon fishing in 1976.

The 1976 coastal catch was 48 percent greater than the 47,242 t taken in 1974, the previous lean harvest year. (Lean and bumper harvest years for salmon alternate in the Northwest Pacific. For that reason, all comparisons are made with 1974 rather than 1975 data.) The most notable change occurred in the pink salmon fishery which increased by 21,291 t, or 66 percent, over the amount caught in 1974. Except for coho salmon, the catches of all other species also increased (see tables).

By area, the catches along the Sea of Okhotsk and Anadyr coasts showed marginal declines from 1974. Catches in the other five areas increased. In particular,

Russia's salmon catch in metric tons and by species, 1971-1976.

| Year | Red | Chum | Pink | Others | Total |
|---|---|---|---|---|---|
| 1971 | 2,249 | 10,546 | 58,445 | 6,355 | 77,595 |
| 1972 | 952 | 5,112 | 20,428 | 4,121 | 30,613 |
| 1973 | 1,713 | 4,345 | 66,449 | 4,351 | 76,858 |
| 1974 | 1,103 | 7,058 | 31,981 | 5,718 | 45,860 |
| 1975 | 1,474 | 6,726 | 68,994 | 5,722 | 82,917 |
| 1976 | 1,128 | 9,789 | 53,272 | 5,534 | 69,723 |



Soviet coastal salmon catch (in metric tons) by area during 1976 and 1974.

| Area and species | 1976 | 1974 |
|---|---|---|
| Sakhalin and the Kuriles | | |
| Chum | — | 1,382 |
| Pink | 37,796 | 25,093 |
| Total | 37,796 | 26,475 |
| Okhotsk Coast | | |
| Red | 1 | — |
| Chum | 386 | 603 |
| Pink | 85 | 2 |
| Coho | 135 | 27 |
| Total | 607 | 632 |
| Northern Okhotsk | | |
| Chum | 386 | 357 |
| Pink | 1,118 | 292 |
| Coho | 2 | — |
| Total | 1,506 | 649 |
| Amur | | |
| Chum | 6,467 | 3,657 |
| Pink | 1,460 | 782 |
| Total | 7,927 | 4,438 |

| Area and species | 1976 | 1974 |
|---|---|---|
| Kamchatka | | |
| Red | 1,127 | 1,040 |
| Chum | 1,443 | 1,070 |
| Pink | 11,919 | 5,646 |
| Coho | 3,473 | 3,910 |
| King | 1,925 | 1,781 |
| Total | 19,887 | 13,447 |
| Primorskii Coast | | |
| Pink | 894 | 1,686 |
| Anadyr | | |
| Red | — | 63 |
| Chum | 1,105 | 1,371 |
| Total | 1,105 | 1,434 |
| Total All Areas | 1976 | 1974 |
| Red | 1,128 | 1,103 |
| Chum | 9,788 | 8,440 |
| Pink | 53,272 | 31,981 |
| Coho | 3,610 | 3,937 |
| King | 1,925 | 1,781 |
| Grand total[1] | 69,723 | 47,242 |

[1]Total does not add because of rounding.

Source: *Shin Suisan Shimbun Sokuho.*

along Sakhalin and the Kurile Islands the salmon take increased by 11,321 t, or 43 percent, and along Kamchatka by 6,440 t, or 48 percent.

These data indicate that the Soviet catch has risen to the high lean-year level registered in 1960 and that the stocks of salmon are abundant in the Northern Pacific. This abundance is evidenced by the fact that the total Soviet coastal catch in recent bumper years was on the level of 70,000 t. Source: *Shin Suisan Shimbun Sokuho.*

## Black Cod, Butterfish Prices High in Japan

Butterfish, caught by Japanese trawlers in waters off New York, continued to hold high prices in February in Japan. The prices being charged on the latest Taiyo Fishery shipment as of 1 February were: ¥13,500/20 kg ($2,126/short ton at ¥288=US$1) for large size, ¥11,000/20 kg ($1,732/short ton) for medium, ¥8,500/20 kg ($1,339/short ton) for small, and ¥7,000/20 kg ($1,102/short ton) for extra small. Comparing with the previous shipments by Kuokuyo and Hoko Fisheries earlier this year, Taiyo's prices remained the same for sizes large and medium, but were between ¥1,000 and 1,500 higher per case of 20 kg for small and extra small.

Prices of black cod in Japan rose sharply since the turn of the new year, and in late January reached ¥500/kg (US$1,575/short ton at ¥288=US$1) for the large size, an all-time high, ¥430/kg ($1,354/short ton) for the medium size, and ¥390/kg ($1,228/short ton) for the small size. The sharp gain in price for black cod was attributed to the general lapse in shipment of northern-water bottomfish. Informed sources predicted further rises in price of black cod and other northern-water bottomfish in February and March, as few shipments were expected during those months. Source: *Suisan Keizai Shinbun.*

## *Mauritanian Fishery Companies Tabulated*

The U.S. Regional Fishery Attache for Africa, William B. Folsom, has prepared a 20-page report on Mauritanian fishery companies. The author briefly summarizes fishery developments in 1974 and 1975 and then describes each company. The major activities of each company are detailed along with basic data on the company's processing plants and/or vessels. Folsom also provides details on joint venture arrangements which Mauritanian fishery companies may have with foreign governments or companies.

A copy of this report may be purchased (paper, $3.50; microfiche, $3.00) by ordering NTIS Accession No. PB-261 862, "Fishery Companies of Mauritania" from the Sales Desk, National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161. Please enclose a self-addressed label to facilitate mailing.

## *USSR Ups Alaska Pollock Cost to Japan 54 Percent*

The prolonged negotiations for this year's high-seas purchase of Soviet-caught Alaska pollock between Japanese fishery firm Hokuyo Fishery and the Soviet Union have reportedly settled on a price of $81.15 per metric ton and a total supply of 65,000 tons. The new price represented a 54 percent hike over last year, whereas the supply remained the same as before. The negotiations were carried out under the influence of the concurrent foreign fishing fee negotiations between Japan and the United States within the U.S. economic zone. The Soviet Union initially proposed $120 per metric ton apparently in keeping with the ex-vessel price of $158 contained in the original U.S. foreign fishing fee schedule, and settled on a price of $81.15 after Japan and the United States subsequently worked out an agreement on an ex-vessel price of $98 per metric ton. Source: *Suisan Tsushin.*

## JAPAN BARRED FROM EC 200-MILE ZONE

The European Community (EC) Commission on 23 February officially notified the Japanese Government of its decision reconfirming the policy of barring Japanese fishing activities within the 200-mile zone of European Community countries and their colonial territories. The decision also refused to negotiate with the Japanese Government on this matter. The European Community had adopted this policy at its foreign ministers council last December, and the Japanese Government has been requesting the Commission to reconsider the decision. As an immediate result of this decision, Japanese fishing activities off French Guyana involving twelve firms and 110 vessels faced a wholesale shutout. Sources: *Suisan Keizai Shinbun* and *Minato Shinbun.*

## Japan's 1976 Fishery Imports Hit New High

Total Japanese imports of fishery products in 1976 were a record both in quantity and value at 817,430 metric tons with ¥563,884 million (US$1,905 million, based on ¥296 = US$1) on a customs clearance basis, according to the Finance Ministry. Compared with 1975, the imports were up 15 percent in quantity and 46 percent in value.

Frozen shrimp imports, which totaled 123,334 tons worth $739 million, led all other products both in quantity and value, accounting for 15 percent in quantity and 39 percent in value of the total imports. Fresh and frozen tuna imports, which totaled $133 million, recorded a 17 percent gain over 1975. Frozen salmon imports, which totaled $11 million, were off 44 percent from 1975. Sources: *Suisan Keizai Shinbun, Minato Shinbun, Shokuyo Shinbun,* and *Suisan Shuho.*

Japanese imports of Fishery Products, 1950-76.

| Year | Quantity in Metric tons | Value (¥ Million) | Year | Quantity in Metric tons | Value (¥ Million) |
|---|---|---|---|---|---|
| 1950 | 6,322 | 699 | 1964 | 232,120 | 32,266 |
| 1951 | 5,995 | 1,316 | 1965 | 278,939 | 37,422 |
| 1952 | 8,480 | 1,201 | 1966 | 333,799 | 60,331 |
| 1953 | 11,945 | 1,915 | 1967 | 330,949 | 68,966 |
| 1955 | 14,336 | 1,966 | 1968 | 370,143 | 72,134 |
| 1956 | 17,151 | 2,617 | 1969 | 362,627 | 93,844 |
| 1957 | 18,272 | 2,647 | 1970 | 374,568 | 114,628 |
| 1958 | 19,602 | 3,351 | 1971 | 398,071 | 153,347 |
| 1959 | 19,270 | 2,766 | 1972 | 480,649 | 190,338 |
| 1960 | 47,476 | 5,523 | 1973 | 658,425 | 300,074 |
| 1961 | 56,634 | 8,173 | 1974 | 604,141 | 323,239 |
| 1962 | 89,623 | 10,694 | 1975 | 710,373 | 385,008 |
| 1963 | 156,330 | 21,385 | 1976 | 813,430 | 563,884 |

Japanese fishery imports by selected species, 1974-76.

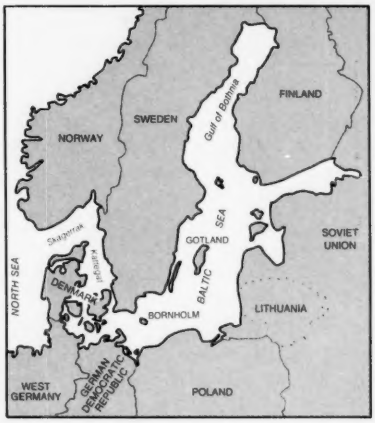
| Fishery products | Quantity (metric tons) | | | Value[1] (US$1,000) | | |
|---|---|---|---|---|---|---|
| | 1974 | 1975 | 1976 | 1974 | 1975 | 1976 |
| Fresh/Frozen | | | | | | |
| Yellowfin | 15,083 | 23,042 | 31,163 | 23,770 | 37,128 | 36,753 |
| Skipjack | 3,322 | 9,623 | 8,863 | 1,485 | 4,301 | 4,514 |
| Albacore | 1,619 | 7,988 | 1,639 | 1,405 | 6,740 | 2,219 |
| Bluefin | 1,725 | 1,867 | 708 | 5,065 | 5,848 | 3,416 |
| Other tuna | 24,896 | 48,427 | 126 | 28,162 | 60,473 | 92 |
| Marlin (incl. swordfish) | 17,616 | 19,116 | 21,536 | 14,632 | 19,041 | 23,189 |
| Porgy | 8,262 | 6,195 | 8,728 | 8,223 | 6,858 | 11,264 |
| Salmon | 3,957 | 6,823 | 3,664 | 9,168 | 19,726 | 11,057 |
| Spanish mackerel | 11,332 | 8,077 | 8,313 | 12,883 | 11,760 | 12,223 |
| Yellowtail | 1,389 | 1,264 | 1,609 | 1,914 | 1,574 | 2,439 |
| Shark | 1,779 | 2,144 | 712 | 777 | 1,331 | 594 |
| Croaker | 3,339 | 2,067 | 2,378 | 2,938 | 2,125 | 4,791 |
| Hairtail | 2,103 | 1,779 | 1,708 | 1,024 | 1,645 | 1,432 |
| Herring | 5,688 | 8,856 | 5,910 | 4,247 | 6,483 | 5,611 |
| Cod roe | 3,133 | 4,421 | 4,136 | 3,041 | 4,010 | 4,368 |
| Herring roe | 103 | 173 | 169 | 285 | 480 | 551 |
| Shrimp | 103,311 | 113,672 | 123,334 | 404,024 | 464,527 | 738,986 |
| Octopus | 67,678 | 74,613 | 94,387 | 71,052 | 81,426 | 121,405 |
| Squid | 44,762 | 58,580 | 68,532 | 63,158 | 99,105 | 135,111 |
| Clam | 17,742 | 15,823 | 14,483 | 12,629 | 9,345 | 9,561 |
| Crab | 9,337 | 10,463 | 12,496 | 17,076 | 16,172 | 28,091 |
| Abalone | 741 | 891 | 1,647 | 3,333 | 3,953 | 7,713 |
| Scallop | 285 | 322 | 144 | 1,199 | 1,378 | 693 |
| Whale meat | 28,578 | 28,822 | 32,475 | 15,660 | 19,676 | 29,176 |
| Live | | | | | | |
| Young eel | 303 | 222 | 137 | 7,704 | 3,838 | 8,594 |
| Adult eel | 7,739 | 10,927 | 14,206 | 46,275 | 64,730 | 79,956 |
| Salted/Dried | | | | | | |
| Salmon roe | 4,335 | 3,486 | 5,773 | 41,120 | 40,071 | 59,429 |
| Herring roe | 12,573 | 7,610 | 11,697 | 67,649 | 46,736 | 97,743 |
| Herring roe on kelp | 249 | 519 | 370 | 1,148 | 2,314 | 1,919 |
| Sea urchin roe (incl. fresh and frozen) | 1,354 | 1,684 | 1,874 | 7,615 | 10,297 | 14,389 |
| Canned | | | | | | |
| Abalone | 679 | 623 | 708 | 3,309 | 3,240 | 5,223 |

[1]Based on ¥ 291 = US$1 for 1974; ¥ 296 = US$1 for 1975 and 1976.

## Sweden to Extend Its Baltic Fishing Zone

A proposal has been presented to the Swedish Parliament (Riksdag) to extend Sweden's fishery limits in the Baltic Sea. Under this proposal, Sweden would control about 45 percent of the Baltic, thereby affecting the fishing zones of Denmark, the German Democratic Republic (GDR), Poland, and the Soviet Union.

A line demarcating the extended fishing zone would begin off the GDR, swing north of Bornholm Island, and off Poland's northern coast and then move north-northeast between the island of Gotland and Soviet Lithuania (see map). The Soviet Union was expected to object to this line as the Swedes measure their baseline from the eastern shore of Gotland while the Soviets measure the baseline as originating from the Swedish mainland. It was uncertain whether Sweden would extend its fishing zone in the Skagerrak and Kattegat straits since fishing there was already regulated by agreements be-



tween Denmark, Norway, and Sweden which were first concluded in 1933. There was no indication that Sweden was considering extending its fishing zone in the Gulf of Bothnia, where an accord with Finland exists.

According to the Swedes, the new proposal was the result of European Economic Community's (EC) extension of its fisheries jurisdiction in the North Sea as well as the recent decision by the Baltic Fisheries Commission to reduce Sweden's fishing effort in the Baltic. Source: U.S. Embassies in Copenhagen and Stockholm.

According to the NMFS Office of International Fisheries, the proposal to extend the Swedish fishing zone to the midline in the Baltic was presented in the Riksdag by S. Lundquist, a former Minister of Agriculture on behalf of opposition parties. In addition to the 1 January 1977 extension of fisheries jurisdiction by the EC in the North Sea, the Soviet Union also was to begin enforcing its 200-mile fishing zone and the Soviet move will require an agreement on the location of the Baltic midline between both states. This was expected to activate a long-standing argument with the USSR which claims that the midline should run halfway between the coast of the Swedish mainland and the Soviet mainland, while Sweden maintains that the midline should run halfway between Gotland and the Soviet mainland.

The Lundquist proposal generated considerable coverage in Swedish news media. The daily *Dagens Nyheter* asserted on 1 February, on the front page, that the Swedish Government would be unable to withstand pressures from Swedish fishermen and the Social Democratic opposition and was planning unilaterally to extend the fishing zone in the Baltic before March, and then negotiate with neighboring countries affected by the extension.

The midline argment with the Soviet Union is essentially the same as is the attempt to divide the continental shelf between both countries. Discussions on the latter have been unsuccessful since 1968.

According to *Dagens Nyheter*, the Swedish extension of its Baltic Sea fishing jurisdiction also worried Danish salmon fishermen who would no longer be able to fish salmon in the Baltic.

## *Japan's 14-Year Frozen Shrimp Imports Listed*

Japanese frozen shrimp imports in 1976 registered all-time highs in quantity and value with 123,334 metric tons at ¥218,740 million (US$739 million at ¥296=US$1) according to the customs clearance data released by the Japanese Finance Ministry. The 1976 imports eclipsed the previous record high of 1973 by 5 percent in quantity and 72 percent in value, indicating that the imports involved not only an increased quantity but also an increased proportion of high-quality shrimp. Thus, the average unit value of the 1976 imports, at $5,992 per metric ton, was also a new record, surpassing the previous high of $4,087 per metric ton for 1975 by a wide margin.

Since Japan liberalized shrimp imports in 1961, purchases from foreign countries have risen year after year save for brief lapses in 1968 and 1974. The 1976 imports experienced an almost elevenfold increase over 1965 and more than a twofold increase over 1970. Up to 1970, Mexico and the People's Republic of China were major suppliers of shrimp to Japan. Since 1971, however, India and Indonesia took over as dominant suppliers with India leading all other countries to date. In 1976, India, still the leader, had its supply slightly behind 1975, whereas imports from Indonesia, Australia, Mexico, the Republic of Korea, and Malaysia increased markedly. India and Indonesia together accounted for 42.5 percent of total Japanese shrimp imports in 1976, a slight decline from the 44.9 percent in 1975. By region, imports from the Far East and Southeast Asia accounted for approximately 80 percent, those from Latin and South America about 8 percent, from Australia and Papua New Guinea 5.5 percent, from Africa 4 percent, and from the Middle East 2.5 percent. Imports from the United States were 332 metric tons. Sources: *Shokuryo Shinbun* and *Suisan Keizai Shinbun*.

Japan's frozen shrimp imports in metric tons, by leading countries, 1963–76.

| Year | Total imports | Value (US$1,000) | India | Indonesia | PRC[1] | Mexico |
|---|---|---|---|---|---|---|
| 1963 | 11,708 | 23,475 | N.A.[2] | N.A. | N.A. | N.A. |
| 1964 | 18,167 | 31,437 | N.A. | N.A. | N.A. | N.A. |
| 1965 | 21,011 | 35,938 | 851 | N.A. | 5,875 | 5,210 |
| 1966 | 36,156 | 60,085 | 993 | N.A. | 11,769 | 4,889 |
| 1967 | 44,466 | 79,732 | 2,147 | 15 | 5,004 | 7,995 |
| 1968 | 35,204 | 78,079 | 3,164 | 661 | 3,769 | 5,769 |
| 1969 | 48,886 | 121,748 | 4,864 | 2,604 | 4,136 | 5,511 |
| 1970 | 57,146 | 137,026 | 6,210 | 3,684 | 6,248 | 7,210 |
| 1971 | 78,874 | 214,591 | 9,702 | 8,223 | 4,990 | 6,520 |
| 1972 | 88,120 | 291,943 | 12,812 | 13,824 | 3,519 | 5,407 |
| 1973 | 117,474 | 429,845 | 21,903 | 18,764 | 4,475 | 8,839 |
| 1974 | 103,311 | 404,024 | 19,898 | 19,385 | 9,483 | 4,580 |
| 1975 | 113,672 | 464,527 | 29,942 | 21,060 | 9,768 | 4,085 |
| 1976 | 123,334 | 738,986 | 26,901 | 25,510 | 5,569 | 5,235 |

[1]People's Republic of China.
[2]Not available.

Japanese frozen shrimp imports in metric tons and by country of origin, 1973–76.

| Country of origin | 1973 | 1974 | 1975 | 1976 |
|---|---|---|---|---|
| India | 21,903 | 19,898 | 29,942 | 26,901 |
| Indonesia | 18,764 | 19,385 | 21,060 | 25,510 |
| PRC | 4,475 | 9,483 | 9,768 | 5,569 |
| Mexico | 8,839 | 4,580 | 4,085 | 5,235 |
| Thailand | 9,884 | 6,314 | 8,837 | 9,849 |
| Taiwan | 5,040 | 3,245 | 3,395 | 3,241 |
| Pakistan | 4,231 | 2,305 | 2,951 | 3,892 |
| S. Korea | 2,571 | 3,127 | 2,932 | 4,673 |
| Malaysia | 5,190 | 2,619 | 2,392 | 3,877 |
| Iran | 859 | 854 | 651 | 803 |
| Australia | 4,769 | 5,189 | 4,663 | 6,189 |
| Hong Kong | 3,052 | 4,051 | 4,140 | 4,627 |
| Cuba | 1,985 | 3,193 | 3,548 | 1,693 |
| Kuwait | 768 | 236 | 379 | 1,031 |
| Vietnam | 662 | 2,154 | 1,639 | 2,356 |
| Philippines | 2,281 | 1,521 | 1,109 | 2,081 |
| Nigeria | 375 | 771 | 867 | 831 |
| Sabar | 1,347 | 1,728 | 1,515 | 2,296 |
| Bahrain | 1,447 | 1,227 | 1,014 | 974 |
| Brazil | 1,196 | 855 | 391 | 770 |
| Liberia | 475 | 611 | 330 | 320 |
| Guyana | 850 | 762 | 939 | 900 |
| Camaroons | 768 | 809 | 474 | 386 |
| Singapore | 831 | 517 | 345 | 336 |
| United States | 636 | 130 | 68 | 332 |
| Bangladesh | 628 | 220 | 339 | 565 |
| USSR | 6,141 | 1,294 | 0 | 0 |
| Total[1] | 117,474 | 103,311 | 113,672 | 123,334 |

[1]Including other countries.

*In Brief. . . .*

# A Tire Reef, "Ghost" Sea Worms, and Abalone Protection

. . . .**Alexander Malahoff, an expert in marine geology and geophysics,** has been named chief scientist of the National Ocean Survey, a NOAA agency. Malahoff thus becomes principal advisor to the NOS Director in geophysical and oceanographic matters, including program planning, budget, research and evaluation of techniques, and scientific analysis and study. Since 1970, Malahoff has been the program director of Marine Geology and Geophysics Program in the Office of Naval Research. . . .

. . . .**A "ghost" sea worm, once known only from its empty** sea-bottom tunnels, was found in a sediment core taken in 4,000 meters (13,000 feet) of water southeast of Hawaii during a Scripps Institution of Oceanography expedition last year. The 9.5-cm (3¾-inch) semitransparent, green, echiurid has no eyes or other distinct sense organs; it depends on isolated sensory receptors in its skin. Discovery of the specimen means that researchers can apply knowledge of the behavior of their shallow-water relatives to learn how they affect the mixing of sediments, the Institution notes. . . .

. . . .**Concern over long-term abalone depletion led** California's Fish and Game Commission to tighten restrictions on commercial abalone diving permits and to close a southern California area to the commercial taking of that mollusk in February, according to the Department of Fish and Game. The action followed imposition of tighter controls on the sport take of abalone late last year. Permits are now limited to divers active during the previous season and to an additional 5 percent annually. Eligibility requirements and testing procedures for new divers have also been set. The commission also closed mainland coastal waters from Palos Verdes Point (Los Angeles County) to Dana Point (Orange County), an area closed to the sport take of abalone last December. Commercial taking or possessing of black abalone within one mile of Anacapa and Santa Cruz Islands in the Santa Barbara Channel is also prohibited. . . .

. . . .**A "tire baler," making artificial reefs from old auto tires** along Texas' coast this summer, is expected to help stimulate and improve fishing for bay anglers from Port Arthur to Corpus Christi, according to the Texas Parks and Wildlife Commission. For the first tire reef in a Texas bay, about 500 modules of 12 tires each were joined, forming a nearly one-acre reef about ¾-mile off Pleasure Island at the south end of Sabine Lake. The reef is 5–7 feet under water depending on the tide. Others were scheduled for off La Porte, Rockport, and Corpus Christi. Surf reefs were tentatively planned for waters off Freeport, Galveston, and Mustang Island, time permitting. . . .

. . . . **The *Endeavor*, a 177-foot steel hull research vessel,** has replaced the University of Rhode Island's first research vessel, the *Trident*. The new vessel has a 34-foot beam and a 17-foot, 6-inch draft and is capable of spending up to 30 days at sea

and travelling 10,000 nautical miles between ports. Her maximum speed is 15.4 knots. The vessel was financed by the National Science Foundation, as were its two sister ships, the *Oceanus* at the Woods Hole Oceanographic Institution and the *Wecoma* at Oregon State University. . . .

. . . .**Cold winter weather, combined with extremely low water** levels, caused a widespread fish kill in many coastal Louisiana parishes, according to J. Burton Angelle, Director of the Louisiana Wildlife and Fisheries Commission. Extent of the fish kill was not determined, but numbers of dead fish were reported in the shallow coastal marshes in the parishes of St. Bernard, Plaquemines, Jefferson, Terrebonne, and Lafourche early this year. Most were reportedly small forage fish, though some dead commercial and sport fish, including large redfish and speckled trout, were also noted. All the fish in the shallow experimental ponds at the Commission's Marine Laboratory on Grand Terre Island also died. . . .

. . . .**Redfish in Texas' Lake Braunig grow about three times** as fast as their Texas bay counterparts, according to the Texas Parks and Wildlife Department. The species was stocked on 29 April 1976 at about 4–6 inches in length to see if saltwater fish could survive in the freshwater lake and take advantage of its abundant forage fish. In February, anglers began taking 4½- to 6-pound (20½- to 22¾-inch) redfish there. Typical of Texas lakes used to cool hydroelectric plants, Lake Braunig has a high ratio of rough or forage fish to game fish. Redfish used in the 1976 stocking were originally spawned at the National Marine Fisheries Service's Port Aransas Laboratory under light and temperature-controlled conditions. . . .

. . . .Plans for **expansion and reconfiguration of the LORAN-C radio** navigation service to the east coast of the United States have been published by the U.S. Department of Transportation. This starts the final step in providing all mariners with LORAN-C navigation coverage throughout the Coastal Confluence Zone of the continental United States and Alaska. LORAN-C system will provide 95 percent assurance that a vessel can fix its position to an accuracy of 0.25 nautical mile. The LORAN-C service will be expanded to the Gulf of Mexico and the southeastern part of the United States around 1 July 1978, and final reconfiguration of the east coast coverage will be completed about 1 July 1979. Coverage will expand to the Great Lakes around 1 February 1980. . . .

. . . .**The U.S. Coast Guard has awarded a multi-million dollar** contract for 41 medium range surveillance (MRS) aircraft to Falcon Jet Corp[1], Tetterboro, N.J. The new planes will replace the aging fleet of Coast Guard HU16E "Albatross" aircraft. Their primary duties will be law enforcement patrol of U.S. territorial waters and the new 200-mile Fishery Conservation Zone, pollution surveillance, and search and rescue. The contract totals $204,846,291, and the first plane is scheduled for delivery in June 1979. . . .

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

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